

THE EFFECTS OF A SIMULATED NATURE EXPERIENCE ON THE
PHYSIOLOGICAL AND BEHAVIOURAL RESPONSES OF YOUNG CHILDREN WITH
POST-TRAUMATIC STRESS SYMPTOMS

A thesis submitted in partial fulfilment for the Degree of Masters of Science in Child and
Family Psychology

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Abbreviations

ART: Attention Restoration Theory

ANS: autonomic nervous system

HPA: hypothalamic-pituitary-adrenal

HRV: heart rate variation

HF-HRV: high-frequency heart rate variation

PNS: parasympathetic nervous system

SCL: skin conductance level

SRT: Stress Reduction Theory

SNS: sympathetic nervous system

PFC: prefrontal cortex

PTSD: post-traumatic stress disorder

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Abstract

Post-traumatic stress symptoms are a common reaction to experiencing a traumatic event such as a natural disaster. Young children may be at an increased risk for such mental health problems as these catastrophic events may coincide with developmentally sensitive periods of development. Treatments currently recommended for children with post-traumatic stress symptoms insufficiently acknowledge the role of neurobiological stress related systems responsible for these symptoms. As such, alternative approaches to the treatment of post-traumatic symptoms have been explored, with nature-based interventions offering a potential alternative based on two different theories that uphold the stress reducing benefits of natural environments. To date, there are a limited number of experimental studies that have explored the use of nature-based interventions with children, and no known research that has used a simulated nature experience with child participants. The purpose of this study was to investigate the effects of a simulated nature experience on the physiological and behavioural responses of children with post-traumatic stress symptoms that experienced the Christchurch earthquakes. A single-case research design with repeated measures of heart rate and teacher-reported behaviour was gathered across a 20-day period. Heart rate data was collected before and after participants watched a 10-minute nature video, while data from a teacher rating scale provided information about the participants' behaviours in the 30-minute period after they watched the nature video. Comparisons made to data collected during two different baseline phases indicated that the nature video intervention had no recognisable effects on the participants' physiological and behavioural stress responses. Limitations to the current study are discussed as possible reasons for the incompatibility between the current study's results and the findings from previous research. Suggestions are made for any future replications of the study.

Chapter 1

Introduction

The Canterbury Earthquakes

Over the past six years, the Canterbury region has experienced the devastating effects of earthquakes and aftershocks. These began on 4 September 2010 when a 7.1 magnitude earthquake struck west of Christchurch city. Although this earthquake caused no fatalities, there was widespread damage to houses and infrastructure in the city. Following this earthquake in 2010 was a sequence of 14,000 aftershocks that rattled the city. Included in this sequence of aftershocks was a 6.3 magnitude earthquake that occurred at 12:51p.m. on 22 February 2011, which resulted in the death of 185 people and left thousands injured.

This 6.3 magnitude earthquake caused damage to infrastructure in schools, workplaces, and community facilities and disrupted the lives of the residents. In addition, countless families and individuals needed to evacuate their homes immediately, while others over the five years following the earthquakes, needed reparations to their home or residence. Reports collated by the Canterbury Earthquake Recovery Authority (CERA) three years after the first major earthquake demonstrated that stress, quality of life, and other negative impacts caused by the earthquake still burdened many individuals (Canterbury Earthquake Recovery Authority, 2014). Most notably affected were individuals with a low income, a disability, or involved in ongoing negotiations with their insurance company. Although initial stressors may arise from experiencing the earthquake and witnessing the devastation caused, Lock et al. (2012) noted that secondary stressors such as financial burden, insurance claims, lack of infrastructure, and concerns about the safety of family can cause distress for a prolonged period of time.

Children and Natural Disasters

Young children are a population vulnerable to the mental health issues that can arise as the result of a natural disaster (Shaw, Espinel, & Shultz, 2012). Whilst older children may experience fear and anxiety associated with their direct experience of the disaster (Yule, 2001), their cognitive maturity may serve as a protective factor. Sprung (2008), for example, found that children aged five to eight years old, with more advanced theory of mind skills, had better coping skills to deal with the instructive thoughts that occurred after a natural disaster. Although younger children's limited cognitive functioning may protect them from understanding the significance of the events, a review by Masten and Narayan (2012) discussed a number of direct and indirect processes that affect younger children as a result of natural disasters. Direct pathways discussed in the Masten and Narayan review included the actual physical damage or injury caused by the disaster, or health related problems that result from issues (such as contaminated water or impoverished living conditions). On the other hand, indirect pathways included factors such as loss of parental protection, availability, and care due to the parent's own stress and psychological response to the disaster. McFarlane (1987), for example, found that mothers' responses to a natural disaster were a strong predictor of mental health outcomes for children. Masten and Narayan (2012) argued that the stress caused to younger children after a disaster may be the result of a social referencing process whereby younger children may learn to read the fear their parents and caregivers express in response to the traumatic event. As such, young children's experiences of natural disasters should be recognised regardless of their ability to understand the significance of the events taking place.

Post-traumatic Stress Symptoms/Disorder (PTSD)

Post-traumatic stress disorder (PTSD) and symptoms of post-traumatic stress are common mental health outcomes of individuals who experience a natural disaster. A review

of child and adolescent mental health outcomes following a disaster showed a wide variation amongst prevalence rates (Wang, Chan, & Ho, 2013). One study however, found that one year following the earthquake in Haiti, over 50% of children displayed severe symptoms of post-traumatic stress (Blanc, Bui, Mouchenik, Derivois, & Birmes, 2015).

The *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association, 2013) characterises PTSD as the intrusive re-experiencing of a traumatic event and avoidance of trauma associated stimuli, coupled with alterations in an individual's mood, cognitions, and arousal. The publication of the DSM-5 included specific PTSD criteria developed for children six years of age and under. This included a focus on observable behavioural symptoms because younger children may have difficulty expressing their internal experiences due to limited cognitive capacities (Friedman, 2013). Dehon and Scheeringa (2005) adapted items from the Child Behaviour Checklist (CBCL) to create a scale that they argued could more effectively identify PTSD in young children. This scale included somatic symptoms such as headaches, stomachaches, and trouble sleeping. A number of externalising behaviours and internalising behaviours were also identified as symptoms of PTSD in children such as: anger issues, difficulty concentrating and paying attention, nervousness, anxiety, and depressed mood.

Although DSM-5 criteria have changed in an effort to more effectively capture symptoms of PTSD among children, research has highlighted a wide variation amongst those attaining a diagnosis when the criteria are adjusted. A number of studies have reported that that young trauma exposed children were more likely to reach diagnostic thresholds when fewer criteria were required or different diagnostic symptoms were used (Scheeringa, Zeanah, Myers, & Putnam, 2003; Sachser & Goldbeck, 2016; Carrion, Weems, Ray, & Reiss, 2002). The authors of these studies emphasised the importance of their research because it demonstrated that many children that are experiencing trauma related symptoms might go

undetected or miss out on receiving remedial services should they fail to meet diagnostic criteria. Furthermore in a post-disaster community, resources may be strained as damage to infrastructure may cause closure to services required to attain a professional diagnosis. Such issues were apparent in Christchurch following the earthquakes as concerns were raised regarding the wait times for youth mental health services (Stewart, 2016).

Canterbury Children Post-Earthquake

Following the Canterbury earthquakes many parents and teachers recognised an increase in concerning behaviours amongst young children (McCrone, 2014). Recently published research by Liberty, Tarren-Sweeney, Macfarlane, Basu, & Reid (2016) has provided quantitative evidence that there has been an increase in the number of children in Christchurch that are displaying symptoms of post-traumatic stress and problem behaviours following the earthquake. The authors used results from teacher completed Problem Behaviour Index (BPI) taken from a cohort of 5-year-old children prior to the earthquake as a baseline measure (pre-EQ [earthquake] group), and compared these to a cohort of same aged children who were two-years-old at the time of the earthquakes (post-EQ group). The results indicated that children in the post-EQ group had significantly higher problem behaviour scores as compared to the pre-EQ group. The authors used items from the teacher completed BPI that reflected symptoms of post-traumatic stress in children, and compared these items between the two groups. The results indicated significantly higher scores of combined symptoms of post-traumatic stress in the post-EQ group. Overall, these findings showed that children who experienced the earthquakes at a young age were more likely to be withdrawn, clingy, irritable, and demonstrate more negative moods and behaviours.

Childhood Disaster Trauma and Future Outcomes

Exploring the long-term developmental implications of natural disaster exposure is critical because these devastating events interact with the regular changes in childhood,

meaning that ongoing development is likely to be affected (Franks, 2011); however, research exploring the long-term effects of exposure to a disaster in childhood is an underreported area. Although studies have highlighted the increased risk of developing PTSD and other mental health disorders in a relatively short-term duration following a disaster (Wang et al., 2013), little research has been conducted that explores the mental and physical health trajectory of childhood disaster exposure into adulthood. One study by McFarlane and Van Hoof (2009) followed individuals who were exposed to bushfires during childhood (mean age 8-years-old). Twenty years on, results indicated that these individuals had a small increased prevalence for anxiety and other mental health disorders compared to a control group, despite 75% of those exposed reporting a degree of distress related to the bushfires. Another longitudinal study by Morgan, Scourfield, Williams, Jasper, and Lewis (2003) reported that individuals exposed to a fatal landslide that destroyed a school had high rates of post-traumatic stress symptoms throughout their lifetime, with 29% still reporting symptoms 33 years later. However, these individuals were not reportedly to be at a greater risk of other psychological disorders such as anxiety, depression, or substance use. In an effort to understand exposure to childhood trauma and long-term outcomes, and in the absence natural disasters based trauma studies, extending the research to include any form of childhood trauma provides a greater understanding. In this case, the research consistently indicates that early life stress or trauma can increase the triggering, continuance, and frequency of mental health disorders in adulthood (Carr, Martins, Stingel, Lembruber, & Juruena, 2013), and increase the risk of health related issues that can burden public health systems (Wu, Schairer, Dellor, & Grella, 2010).

Hyperarousal Symptoms

Hyperarousal is increased physiological arousal that is dysfunctional, severe, and uncontrollable for individuals with PTSD (Weston, 2014). Individuals in a hyperaroused state

describe a startled feeling while experiencing an increase in sweating, tension, and heart rate (Weston, 2014). A number of physiological and behavioural symptoms have been attributed to the presence of hyperarousal. Table 1 provides an overview of these symptoms and studies that have explored the connection with hyperarousal. Information in the Table 1 also provides details regarding the measures used in these studies to explore the nature of this symptom.

Table 1: Symptoms Related to Hyperarousal

Symptom	Description	Measurement	Article
Increased sweating	Increased perspiration on skin	Devices that measure skin conductance via sensors	D'Andrea, Pole, DePierro, Freed, & Wallace (2013); Keysor, Mazzocco, McLeod, Hoehn-Saric (2001)
Higher resting heart rate	Heart rate is above normal range beats per minute when at rest	Changes in blood volume measured by photoplethysmograph or electrocardiogram (ECG)	D'Andrea et al. (2013); Buckley & Kaloupek (2001)
High blood pressure	Increased pressure of blood in circulatory system	Pressure of blood in circulatory system as measured by sphygmomanometer	Li et al. (2015)
Gastrointestinal issues	Nausea, gas and/or indigestion	Self-report scales	Zhang et al. (2015)
Bowel issues	Constipation and/or diarrhoea	Self-report scales	Zhang et al. (2015)
Muscle tension	Muscles are contracted or semi-contracted for an extended period.	Electromyography (EMG)	Hovanitz, Filippides, Lindsay, & Scheff (2002)
Anger outbursts/aggression	Verbal and non-verbal aggression	Self-report of behaviours	Pavic (2003); Mazer & Haden (2014)
Problems with concentration	Difficulty remaining on-task.	Self-report of behaviours; observation of behaviours	Lysaker et al. (2015); Boccia & Roberts (2000)
Sleep issues	Insomnia, troubles falling asleep or staying asleep	Self-report of scales	Zhang et al. (2015); Nofzinger et al. (2004); Wallhäuser-Franke, Schredl, & Delb (2013)

Hyperarousal, arguably, should receive the most clinical and theoretical attention when examining symptoms of post-traumatic in a child population. Firstly, compared to the PTSD criteria of intrusion, avoidance, and altered/negative cognitions that require introspection, symptoms of hyperarousal are more behaviourally anchored (Friedman, 2013). This reasoning does not disregard that children may experience these cognitive symptoms, but suggests that hyperarousal may be more easily identified. Scheeringa et al. (2003) reported that hyperarousal symptoms were frequently described in their sample of young children with PTSD with 45% reporting two symptoms and 73% reporting one symptom. Conversely, cognitive symptoms were less reported. Secondly, research has identified the importance of hyperarousal in the overall symptomology, severity, and development of PTSD (Schell, Marshall, & Jaycox, 2004; Weston, 2014). Schell et al. (2004) found that the presence of hyperarousal strongly influences the overall improvement PTSD symptomology. Trauma exposed individuals with hyperarousal as their most evident symptom at baseline had poorer overall improvement in their symptoms of PTSD a year later, whereas individuals with lower baseline levels of hyperarousal symptoms had better improvement in their overall PTSD symptoms. Severity of hyperarousal has also been found to predict subjective quality of life in individuals with post-traumatic stress symptoms. Giacco, Matanov, & Priebe (2013) found that veterans in their study who reported lower symptoms of hyperarousal rated higher in subjective quality of life, and vice-versa. The authors outlined that their results reflected a bi-directional influence: a decrease in hyperarousal could improve subjective quality of life, or an increase in subjective quality of life could improve hyperarousal. Nevertheless, research on hyperarousal emphasises the importance of this symptom in the severity and course of post-traumatic stress, and suggests that targeting this symptom may be a beneficial approach when exploring interventions with young children.

Stress Exposure and the Brain

A vast amount of research has explored the contribution of various brain structures and their functions in the symptomology of individuals exposed to traumatic events. Although inconsistencies across study findings cannot provide an absolute understanding of how exposure to trauma affects the brain (Karl et al., 2006; Etkin & Wagner, 2007; Patel, Spreng, Shin, & Gerard, 2012; Kühn & Gallinat, 2013) there is a general consensus that certain areas are either hypo- or hyperactive as a response to trauma (Patel et al., 2012). Three areas of the brain commonly identified in the PTSD literature are the prefrontal cortex, the hippocampus, and the amygdala (Shin, Rauch, & Pitman, 2006).

Prefrontal cortex. The prefrontal cortex (PFC) is a region of the brain responsible for higher order cognitive functioning. An important function in relation to symptoms of post-traumatic stress is its ability to regulate fearful emotions. When in a calm, relaxed, and alert state, individuals can activate top-down cognitive functioning using the PFC to regulate thoughts, behaviours, and emotions (Arnsten, 2015); however, exposure to stress or traumatic events can reduce activity in the PFC which leads to a decreased ability to regulate and to respond to fearful information signalled by the amygdala (Arnsten, 2015). A study investigating executive functioning through a response-inhibition task found that trauma exposed youth had weaker functioning in areas of the PFC compared to healthy controls when performing a specified task (Carrion, Garrett, Menon, Weems, & Reiss, 2008). Overall, this provides evidence that deficits in PFC function in trauma exposed individuals may contribute to some behavioural symptoms of post-traumatic stress such as anger outbursts and difficulties with concentration. Deficits in PFC activity may inhibit a trauma exposed individual's ability to regulate effectively their emotional reaction to fearful stimuli, as well as impairing their attention and concentration.

Hippocampus. The hippocampus is responsible for processes relating to memory and the encoding of context specific information. Researchers have hypothesised that the hippocampus is hypo-responsive in some individuals with PTSD (Shin et al., 2006) and an imaging study has indicated that youth exposed to trauma have reduced hippocampal activation in comparison to controls during a verbal memory task (Carrion, Haas, Garrett, Song, & Reiss, 2009). However, the association between symptoms of post-traumatic stress and the structural abnormalities is not clear in the literature (Woodward et al., 2009).

Levy-Gigi, Szabo, Richter-Levin, & Kéri (2015) reported that a deficit in hippocampal volume may contribute to individuals with trauma exposure overgeneralising negative contexts. In the Levy-Gigi and colleagues' study, participants with post-traumatic stress symptoms and a control group without post-traumatic stress symptoms were required to complete a cue and context task where stimuli with either a negative or positive context were presented. Compared to the control group, individuals with post-traumatic stress symptoms had more difficulty learning that a stimulus that was previously presented in a negative context could later be associated with a positive outcome. Furthermore, the researchers also reported a correlation between reduced hippocampal volume and an overgeneralisation of negative outcomes (Levy-Gigi et al., 2015). These findings provide an insight into symptoms of re-experiencing in individuals with post-traumatic stress symptoms. Moreover, an increased tendency to overgeneralise negative context may lead to negative moods and an inclination to negatively appraise environmental context.

Information specific to an individual's traumatic event may also trigger memories of the trauma and lead to a fear response. For example, in a study by Garrett et al. (2012), youth exposed to interpersonal trauma had greater hippocampal activation in response to fearful and angry faces, and less activation in response to happy faces compared to healthy controls. The authors suggested these findings showed a predisposition for participants to recall

information related to their interpersonal trauma (Garrett et al., 2012). Importantly also, the hippocampus is activated in conjunction with the area of the brain responsible for fear appraisal. This area, the amygdala, is described below.

The amygdala. The amygdala is an area of the limbic system that plays a role in fear regulation and evaluating the emotional significance of incoming stimuli (LeDoux, 2003). LeDoux (2003; 2007) described the amygdala as the primary site in the brain where information from external stimuli arrives through the various sensory systems (i.e., visual, auditory, olfactory, taste, and somatosensory), where it is rapidly detected for adversity and produces a behavioural or affective response that is adaptive for survival. Various connections allow projection of this appraised sensory information to a number of different regions of the brain such as the PFC, hippocampus, and brain stem (Shin et al., 2006; Tottenham & Sheridan, 2009; LeDoux, 2003; Weems et al., 2013; Buijs & van Eden, 2000). Importantly also, this incoming sensory information, registered by the amygdala, can be stored implicitly so responses to environmental stimuli can occur without conscious thought (Phelps & LeDoux, 2005)

Because of its function in fear appraisal, the amygdala's role in post-traumatic stress symptoms has been widely studied. Like other brain regions outlined earlier, there is no apparent differences in the size of the amygdala between individuals with PTSD in either adult (Karl et al., 2006; Woon & Hedges, 2009) or child studies (Weems et al., 2013). There is, however, a consensus in the research that suggests that the amygdala is over reactive in individuals with PTSD. For example, Bruce et al. (2013) found that adult women exposed to interpersonal trauma had higher amygdala activation when observing emotionally laden images unrelated to their trauma. Similar results have been demonstrated in child populations in the study by Garrett et al. (2012), demonstrating heightened amygdala activity in participants with post-traumatic stress symptoms compared to a group of healthy controls

when shown images of different facial expressions. The functional magnetic resonance imaging (fMRI) results from this study also illustrated the importance of connectivity between the amygdala and areas of the brain responsible for regulating emotion. Participants with PTSD had lower activation in the PFC suggesting less capability to evaluate the stimuli and regulate their emotional response (Garrett et al., 2012).

Individuals with post-traumatic stress symptoms following a natural disaster demonstrated similar results. In a study by Jin et al. (2014), individuals with PTSD following an earthquake were found to have weaker positive connections between the PFC and the amygdala indicating a decreased ability to regulate and process emotions created by the amygdala. Interestingly, this study also found a negative correlation between amygdala and PFC connectivity and severity of PTSD symptoms. Participants with weaker connectivity between the amygdala and the PFC scored higher on a measure of PTSD symptom presence and severity, suggesting that higher positive connectivity may help moderate symptoms of post-traumatic stress following a natural disaster (Jin et al., 2014).

Neurobiological Development and Exposure to Stress in Childhood

Developmental timing of traumatic events is an important factor to consider when exploring the relationship between post-traumatic stress symptoms and associated brain regions. Lupien, McEwan, Gunnar, and Heim (2009) outlined that research involving both animal and human populations has highlighted the plasticity and malleability of neurobiological development at sensitive periods in early childhood. Sensitive periods refer to particular windows where development of normal or healthy brain function is dependent on expectant experiences, whereas traumatic or unexpected events may have destructive effects on neurobiological development (Heim & Binder, 2012). There is variation in relation to the areas of the brain and the particular timeframe where critical development is taking place (Tau & Peterson, 2010). For example, the development of the amygdala has been

shown to be rapid in the first year of life (Gilmore et al., 2011), allowing the development of functions required to evaluate environmental stimuli for potential safety or danger (Fareri & Tottenham, 2016). The regions responsible for higher order processes, such as the PFC, are slower in development with maturation of this area not beginning until approximately eight years of age (Giedd et al., 2009). Due to this asynchronous development across brain regions, infants and young children are unlikely to be unable to regulate effectively the emotionally laden environmental stimuli, assessed by the amygdala. Overactivation of the amygdala due to a traumatic event in the absence of high-order reasoning capacities can negatively strengthen connectivity and functioning through myelination of this stress response system (Heim & Binder, 2012).

Arousal Regulatory and Stress Activated Systems

The human body responds to psychosocial stressors that are received by the amygdala through activation of physiological systems designed to protect individuals from perceived threat or danger. The term *allostasis* has been used in the literature to describe the biological process that aims to maintain stability in the event of an environmental change (McEwan, 1998; McEwan & Seeman, 1999). Allostasis occurs by allowing individuals to respond to stress in either a physiological or behavioural manner and maintain this adaptive response until the perceived stress or threat has subsided. Two physiological systems that are frequently activated to maintain allostasis are the autonomic nervous system (ANS) and the hypothalamic-pituitary-adrenal (HPA) axis. Although activation of these two physiological systems is adaptive for survival, allostatic load can occur when chronic or repetitive exposure to stress leads to these systems being overworked or unable to be shut off, even when the perceived threat has subsided (McEwan, 1998). The ANS and HPA axis are frequently referred to in the literature that explores PTSD because they both contribute to symptoms and

health related issues associated with the disorder (Gupta, 2013). Recently, Rotenberg and McGrath (2016) argued that the functioning of the two systems are inter-related and should be examined collectively when exploring the effects of stress in children; however, the functioning and effects of each system is described separately below.

Autonomic nervous system (ANS). LeDoux (1998) described the process by which environmental stimuli can trigger a physiological stress response. As described earlier, sensory information reaches the amygdala through various neural pathways. From here it travels through various intra-amygdala pathways until it reaches the lateral nucleus of the amygdala and signals various defence response systems, one of which is the ANS (LeDoux, 1998). The ANS is a branch of the central nervous system that works under involuntary control, and innervates to every organ in the human body (Mathias & Bannister, 2013). It is divided into the sympathetic nervous system (SNS) and parasympathetic nervous system (PNS). The SNS is an excitatory system responsible for controlling the *fight or flight* response to a perceived threat by activating a number of physiological reactions to stress such as increased heart rate, sweating, and muscle tension (Jansen, Van Nguyen, Karpitskiy, Mettenlieter & Loewy, 1995). The function of this physiological response is to prepare an individual to overcome the perceived environmental threat. In contrast, the PNS is an inhibitory system that works during times of rest and relaxation to restore homeostasis (i.e., stability to the body) (Mathias & Bannister, 2013). It is hypothesised that individuals with post-traumatic stress symptoms have increased SNS activity and decreased PNS activity (van der Kolk, 2006).

In light of the description provided by LeDoux (1998), increased amygdala activity would subsequently cause increased SNS activity as the system responds to a perceived threat by physiologically preparing to overcome it. Research by Yang et al. (2007) has demonstrated the link between hyperactivity in the amygdala and increased SNS activation.

Healthy adolescent participants were shown images of fearful faces while heart rate measures were gathered in conjunction with fMRI information. The results indicated a positive correlation between heart rate and amygdala activation suggesting that SNS response is a function of amygdala hyperactivity (Yang et al., 2007).

It is therefore likely that individuals with post-traumatic stress symptoms would have increased SNS activity due to hyperactivity of the amygdala. A meta-analysis by Pole (2007) explored this by examining the results of psychophysiological measures of hyperarousal across 122 studies. The results from the research indicated that individuals with post-traumatic stress symptoms showed increased SNS activity compared to healthy controls evidenced by increased sweating, heart rate, and muscle tension. Importantly also, this increased SNS activity in individuals with PTSD was evident in studies when participants were at rest, when a startle response was elicited, or they were shown standardised or ideographic trauma cues (Pole, 2007).

The increased SNS response to stress is a contribution of both SNS activity and an inhibitory response from the PNS that shuts off in response to stress (Porges, 1995; 2007). Heart rate and heart rate variation (HRV) have been described as practical measures because they are influenced by both SNS and PNS activity (Lang, Bradley, & Cuthbert, 1998; Porges, 1995; Acharya, Joseph, Kannathal, Lim, & Suri, 2006). Using an animal study, Cohen et al. (2007) examined the long-term effects of juvenile trauma exposure on ANS functioning using measures of HRV and heart rate to reflect both PNS and SNS activity. Rats were exposed to a stressor either when they were juveniles (28 days post-natal) and again when they were adults (60 days post-natal), or when they were adults only. Results indicated that ANS activity of the rats shifted towards a SNS dominance following the trauma. However, an important finding was that ANS recovery following the adult stressor was more rapid only in the rats that did not experience the juvenile stress exposure. In contrast, rats exposed to the

juvenile stress did not show a tendency towards ANS recovery. The authors suggested that these results highlight the adverse effects of trauma exposure during critical periods of development where brain structures are malleable to impact of stressful environments (Cohen et al., 2007). Furthermore, the authors also suggested that exposure to early life trauma can have long-term effects on reactivity to future stressors because the ANS may not fully recover from the stressor experienced during this critical period of neurobiological development.

Hypothalamic-pituitary-adrenal (HPA) axis. The hypothalamic-pituitary-adrenal (HPA) axis is another key stress response system that plays an important role in the development of post-traumatic stress symptoms. Lupien et al. (2009) described the process in which the HPA axis regulates the release of cortisol, a hormone excreted to help the body prepare during times of stress. In response to stress, the amygdala secretes serotonin which signals the hypothalamus to secrete corticotropin-releasing hormone (CRH), which then binds to CRH receptors in the pituitary gland. This binding signals the release of adrenocorticotrophic hormone (ACTH) that binds to receptors on the adrenal cortex and activates the release of cortisol. The release of cortisol acts to prepare the individual to cope with the stressor by mobilising energy to areas of the body that are required to effectively work against the perceived threat (Dedovic & Duchesne, 2012). Once the perceived stress has subsided, feedback loops are activated at various points of the system to shut off the HPA axis, and return the individual back to a point of homeostasis (Lupien et al., 2009).

The role of the HPA axis and cortisol levels in individuals with post-traumatic stress symptoms has been widely studied; however, research has revealed a number of inconsistencies across findings. Namely, cortisol levels appear to be either lower (Wessa, Rohleder, Kirschbaum, & Flor, 2006) or higher (Lindley, Carlson, & Benoit, 2004; Inslicht et al., 2006) amongst this population. Results from two meta-analyses by Meewisse, Rietsma,

de Vries, Gersons, and Olf (2007) and Klaassens, Giltay, Cuijpers, van Veen, and Zitman (2012) both revealed no significant difference in cortisol levels between individuals with and without PTSD. However, in Meewisse et al. (2007) particular subgroup analyses indicated lower cortisol levels in females, victims of sexual or physical abuse, and studies where samples were taken in the afternoon, indicating lower cortisol levels may pertain to certain conditions. Klaassens et al. (2012) also noted that inconsistencies across studies could be due to different measurements employed to identify HPA axis activity. Both meta-analyses also excluded childhood trauma, which Klaassens et al. (2012) argued was important to consider because trauma during the early years may have a differential effect on HPA axis functioning.

Research exploring cortisol levels amongst children with post-traumatic stress symptoms has highlighted certain patterns in their results. Delahanty, Nugent, Christopher, and Walsh (2005) found a relationship between children's cortisol levels following a trauma and the severity in the development of post-traumatic stress symptoms. In this study, urinary cortisol measures were taken from children aged eight to 18 years of age, who were admitted to hospital following a traumatic accident or experience (motor vehicle accident, sports injury, or assault). A six-week follow up assessed the severity of the participants' post-traumatic stress symptoms. Results indicated that participants who had higher levels of cortisol reported higher number of symptoms in the six weeks after their traumatic experience (Delahanty et al., 2005). A cross-sectional study by Weems and Carrion (2007) reported similar results for children recently exposed to a trauma; however, as the trauma became more distal, there appeared to be a reversal in the relationship with higher levels of symptoms associated with lower levels of cortisol. More recently, Simsek, Uysal, Kaplan, Yuksel, and Aktas (2015) found similar results that indicated a decrease in cortisol levels with increasing time following the trauma. Southwick, Yehuda, and Wang (1998) hypothesise that this

pattern of cortisol levels that is specific to post-traumatic stress related disorders is due an over reactive negative feedback inhibition. They proposed that high levels of cortisol initially following a trauma causes a biological sensitisation to the feedback loop that switches off cortisol production after the stress has subsided, which leads to a suppression in the production of cortisol over time.

Exploring the effects of cortisol may help explain the relationship between the hormone and the development of post-traumatic stress symptoms. Specifically, brain imaging studies have demonstrated that cortisol may enhance growth in areas of the brain responsible for processing fearful emotions, and decrease growth in areas responsible for regulating emotions. In animal studies, prolonged exposure to cortisol has been shown to cause dendrite remodelling in areas of the PFC (Shansky, Hamo, Hof, McEwen, & Morrison, 2009), while human adult twin studies have identified the important role of cortisol in decreasing prefrontal cortical thickness not explained by genetic variables (Kremen et al., 2010). Similar results were found in youth studies where increased cortisol levels were associated with decreased PFC volume (Carrion, Weems, Richert, Hoffman, & Reiss, 2010). However, in a study by Suor, Sturge-Apple, Davies, Cicchetti, and Manning (2015) results indicated that both elevated and low levels of cortisol were associated with cognitive functioning in children at aged four who had experienced family adversity. Because cognitive performance is a function of the PFC, this result may suggest that both high and low levels of cortisol can have a deleterious effect on this area of the brain. In addition, cortisol has been found to increase amygdala activity (van Stegeren, Wolf, Everaerd, & Rombouts, 2007) and weaken the functional activity between the amygdala and the PFC (Veer et al., 2012). These positive connections that are reduced by high levels of cortisol are likely to moderate the ability of an individual to effectively modulate their emotional response to a stressful environmental stimulus.

Interventions for Treatment of Post-traumatic Stress Symptoms in Children

Traditional interventions. A Cochrane Collaboration review published in 2012 examined the effectiveness of different psychological therapies for the treatment of PTSD in children and adolescents (Gillies, Taylor, Gray, O'Brien, and D'Abrew, 2013). Among the studies reviewed, cognitive behaviour therapy (CBT) was the most commonly used treatment, and is a popular approach to working with children and adolescents with post-traumatic stress symptoms (Shaw, Espinel & Schultz, 2012). Eye movement desensitisation and reprocessing (EMDR) is another traditional treatment that has been used for the treatment of post-traumatic stress symptoms. Although treatment is not limited to these options, they are both reviewed, and their efficacy for a child population is discussed in relation to current understandings regarding the nature of post-traumatic stress symptoms in children.

Cognitive behaviour therapy (CBT)/trauma-focused CBT. Cognitive behaviour therapy (CBT) is used for individuals exposed to trauma to challenge the negative, maladaptive patterns of thinking in relation to the traumatic event, and create more positive thoughts and behaviours (Shaw et al., 2012). Cohen, Mannarino, and Deblinger (2006) developed a cognitive behavioural intervention that was specifically developed for use with individuals who have experienced a trauma. Trauma-focused cognitive behavioural therapy (TF-CBT) is a treatment approach used by clinicians working with trauma exposed children and their parents (Cary & McMillen, 2012) and international guidelines advise the use of TF-CBT when working with this population (Foa, Keane, Friedman, & Cohen, 2008). The eight-component intervention begins with psychoeducation around trauma, and the development of parenting, relaxation, affective modulation, and cognitive coping skills (Cohen et al., 2006). In later sessions, the intervention moves towards exposure to trauma-specific components. The efficacy of TF-CBT has been evaluated in a review by Cary & McMillen (2012) that found a reduction in PTSD symptoms, depression, and behaviour problems immediately after

a TF-CBT intervention across 10 studies. However, while reductions in overall PTSD symptoms remained 12-month follow-up post-intervention, results indicated that depression and problem behaviour had increased at this follow up point. Their review also revealed there was no difference in effectiveness between participants who received TF-CBT and active controls. Furthermore, while the Cochrane Collaboration review also highlighted CBT as the most effective form of therapy for children and adolescents with PTSD, they cautioned that this effectiveness was only evident for up to a month after the treatment (Gillies et al., 2012).

Despite the advised use and frequent study of CBT and TF-CBT, there are a number of limitations with this form of intervention. Firstly, as outlined by the two reviews above, there is little evidence for the long-term effectiveness of CBT and TF-CBT past immediate completion of the treatment. Secondly, CBT and TF-CBT may be ineffective because they require the use of brain regions that may be affected as a result of trauma. Specifically, higher order cognitions are required for children to identify and modify trauma related information, and this requires the use of the prefrontal cortex (Fleming & Dolan, 2012). However as outlined earlier, stress related responses such as the production of cortisol have been shown to impair PFC functioning. Furthermore, adult studies have shown that metacognition is impeded when in a state of hyperarousal (Lysaker et al., 2015). In addition, although DSM-5 criteria has been adapted to include individuals, who may not have been directly exposed to the trauma, CBT, or TF-CBT would likely be ineffective without any event specific thoughts or cognitions to manipulate. This may be particularly poignant for young children with trauma related symptoms whose young age may inhibit specific recollection of traumatic events. Finally, LeDoux (1993) contends that emotional memories related to trauma can be stored in the amygdala without processing the information in the hippocampus where it can be retrieved by the PFC. For this reason, CBT would not be able to access these implicitly

stored memories because they are not contained in an area of the brain involved with cognitive processes.

Eye movement desensitisation and reprogramming (EMDR). Sharipo and Solomon (1995) developed the treatment of eye movement desensitisation and reprogramming (EDMR) for use with individuals with PTSD. It involves the individual recalling trauma related thoughts while the therapist administers bilateral stimulation, usually in the form of eye movements. The treatment was developed in line with Adaptive Information Processing (AIP) Model (Shapiro & Forrest, 2001), which suggests that traumatic experiences are the results of inadequate information processing. The AIP model proposes that memory networks are linked with thoughts, images, and sensory information of the traumatic experience; however, this information is not complete and new information regarding the event may not be adequately forged within the memory network. It is hypothesised that recalling the traumatic event whilst experiencing an external cue, such as the eye movement, will adequately process the event and desensitise the memory. A meta-analysis exploring the efficacy of EDMR for treatment of PTSD in children, provided a medium effect size ($d=.56$) across the results of seven studies (Rodenburg, Benjamin, de Roos, Meijer, & Stams, 2009).

Like CBT and TF-CBT, there are limitations in the use of EMDR for the treatment of PTSD. Schubert and Lee (2009) noted some of these criticisms including a deficiency in explanatory mechanisms as to how EMDR works, and its similarities to exposure therapy and CBT, making it not a distinct type of therapy. However, as with CBT and TF-CBT, individuals are required to consciously recall events surrounding the traumatic event, which as outlined above, may be impeded due to impaired cognitive functioning and the inability to consciously recall information related to the trauma.

Non-Traditional and Alternative Interventions. Van der Kolk (2006) argued that the traditional approaches to treatment of post-traumatic stress symptoms do not pay

sufficient attention to the brain centres responsible for the storage of emotions related to trauma, nor to the neural pathways that regulate physical and emotional hyperarousal. In relation to this, Metcalf et al. (2016) recently explored emerging alternative approaches to the treatment of post-traumatic stress symptoms in adults that focus on the mind-body connection, and rely less on addressing cognitions and beliefs surrounding traumatic events. Although the literature around these treatments is still growing, the review found that the alternative interventions reviewed showed promising efficacy for the treatment of post-traumatic stress symptoms. Presented below is an overview of alternative interventions for the of post-traumatic stress symptoms in both adults and children. Links are made between the nature of post-traumatic stress symptoms in relation to brain structure and functioning, physiological systems, and their relationship with symptoms of hyperarousal.

Art therapy. In a review article by Orr (2007), the author described studies that had used art therapy with children, following a natural disaster. In this review, art therapy was described as a process that allowed children an opportunity to explore, in a safe context, their experiences of the disaster and allows them an opportunity to express feelings and emotions that would otherwise be difficult to express verbally. Stress reducing effects were also described as an outcome from these studies because the art and drawing was a cathartic process (Orr, 2007). Similar stress reducing benefits were provided as rational for the use of art therapy with veterans with PTSD. Spiegel, Malchiodi, Backos, and Collie (2006) reasoned that art therapy might be beneficial for reducing symptoms of arousal, because the process can be a relaxing or even a meditative experience.

Zhu et al. (2014) recently explored the effects of calligraphy on the reduction of hyperarousal symptoms in children who developed PTSD following an earthquake. The authors likened the calming and attention provoking benefits of calligraphy to those of mindfulness practices, which requires the individual to pay attention and be aware of the

present experience. They also described the sensory feedback provided through calligraphy as one of the theoretical framework for its stress reducing effects. The results of the study upheld this theory because the results indicated a significant reduction in self-reported arousal and salivary cortisol levels (Zhu et al., 2014).

Overall, the meditative experience described by the research indicates that art therapy may be helpful in engaging areas of the brain that facilitate cognitive functioning which may be affected due to trauma related stress. Furthermore, art therapy provides a sensory experience that may reduce the activation of brain areas that process incoming stimuli, thereby reducing symptoms of hyperarousal. Orr (2007) argues that although research shows promising potential as a treatment for post-traumatic stress symptoms in children, the lack a specific and well-established theory as to how art therapy works limits its grounding in scientific research.

Music therapy. Foran (2009) described the use of music to improve the emotional dysregulation in trauma-affected children. The author suggested that music provides relaxing, predictable, and non-threatening auditory stimulation whilst enhancing attention and improving functioning of the PFC. In a study by Carr et al. (2012), the authors explored the use of group music therapy for individuals with post-traumatic stress symptoms who had not responded to CBT. The results indicated an improvement in post-traumatic stress symptoms, following a 10-week intervention. Exit interviews provided important information about the important features of the intervention in relation to hyperarousal symptoms; while initially participants felt overwhelmed and agitated by the noise of the instruments, many also reported that banging on the drums provided relief of physiological stress.

Jiang, Rickson, and Jiang (2016) also outlined important findings in relation to the stress reducing effects of music therapy. The authors highlighted that participants reported that familiar music was effective in promoting positive feelings and reducing stress,

indicating a potential link between emotional regulation systems and regions responsible for memory. In relation to this link, a review by Koelsch (2014) reported that music may evoke feelings by establishing beneficial links between the amygdala and the hippocampus, or by prompting neurogenesis of the hippocampal area that may have been damaged due to individuals experiencing chronic states of stress.

There are similar positive findings across studies that have explored the use of music therapy with a child population. These studies have recognised similar benefits to art therapy, such as providing children with the calming and non-threatening medium of music to express feelings and emotions in a non-verbal manner (Kim, 2015). For example, the study by Kim (2015) found that children who were subjected to neglect and abuse responded to a music therapy intervention, and results from pre-post measures on the CBCL showed increased attention and reduced aggressive behaviours. Felsenstein (2013) also acknowledged the benefit of music therapy to express emotions through a non-verbal manner when working with preschool children exposed to trauma after their families were forced from their homes in the Gaza Strip. The author also acknowledged the use of music to help the children regain a sense of control over their physical selves which trauma undermines. As outlined earlier in the chapter, trauma related stress and arousal is often expressed physiologically, especially in children. Music may help give children a sense of control over this and reduce heightened states of arousal.

Nature as a Potential Intervention for Post-traumatic Stress Symptoms

Studies of post-traumatic stress have frequently identified the role of the amygdala in symptoms of hyperarousal. Because the amygdala processes incoming stimuli from various sensory systems, providing non-threatening stimuli could reduce activity in this fear appraisal system. Nature provides individuals with visual, auditory, tactile, and olfactory stimulation. Early ideas from Wohlwill (1983) suggest that the brain and sensory system responsible for

perceiving and appraising threat evolved in a time where humans lived in natural environments. It can, therefore, be hypothesised that humans may have an implicit evolutionary preference for natural environments. A study by Kim et al. (2010) provides evidence that may support these ideas. In their study, fMRI identified areas of the brain that were responding while participants viewed images of natural and urban environments. Essentially, results illustrated that the areas of the brain responding to the urban images are usually associated with more negative emotions such as depression and anger, whereas the areas responding when nature images were viewed are generally more associated with positive emotions such as happiness induced recall (Kim et al., 2010). Arguably the most significant finding was that the amygdala was activated when participants viewed the urban environments, but not the nature environments. As such, viewing nature may potentially enable individuals to reduce the activation in this area of the brain involved in stress related responses.

Two theories related to the psychophysiological benefits of nature have also been developed that align with the idea that nature may be a beneficial intervention for individuals with post-traumatic stress symptoms. Although both these theories are complementary, their distinctions lay in the type of stress they propose nature may reduce. According to Berto (2014), while one theory is aligned with an evolutionary approach to stress reduction and focuses on physiological stress, the other theory adopts a functionalist approach to stress reduction and acknowledges that nature may benefit mental fatigue or stress. Nonetheless, the function through which nature may provide psychophysiological benefits for post-traumatic stress symptoms is explained by both theories, which are outlined below.

Stress reduction theory (SRT) provides an evolutionary perspective that supports the stress reducing benefits of nature (Ulrich, 1981; 1983). In SRT, it is proposed that individuals are physiologically adapted to natural environments because a long duration of human

evolution occurred in a natural environment (Ulrich, 1983). Accordingly, unthreatening nature scenes may be able to evoke feelings of calmness and safety because they provided humans with resources, such as food and water, and a place of refuge from predators and the elements. Because of this, Ulrich (1983) argues that images of natural environments are able to evoke a biological predisposition to react positively and reduce arousal in stressed individuals. Proponents of SRT also acknowledge that urban or non-natural environments may induce arousal as humans have no predisposition for built or urban environments that are more synonymous with our modern living (Berto, 2014). There is growing interest in the increasing amount of individuals, especially children, who are becoming nature deficit (Louv, 2008), leading to a search for ways to connect with nature more frequently in everyday life to benefit from its stress reducing properties (see Kaufman, 2016; Thomas, 2016).

The second theory, Attention Restoration Theory (ART) (Kaplan, 1995; Kaplan & Kaplan, 1989), focuses on the cognitive benefits of natural environments that may be weakened by stress. In ART it is suggested that humans have two forms of attention mechanisms. The first, directed attention, involves effortful control and is subject to fatigue, whereas the second, involuntary attention does not involve effortful control (Kaplan, 1995). Attention Restoration Theory suggests that natural environments draw individual's involuntary attention and allows them to become spontaneously attentive to the sensory stimulation of their environment. While this occurs, neural resources that are required for directed attention, such as the PFC, can be replenished (Kaplan & Berman, 2010). Kaplan (1995) noted three important components that natural environments must contain in order for them to effectively evoke involuntary attention or "soft fascination" (Kaplan, 1995, p.172). Firstly, the component of *being away* suggests that natural environments must be different from the individuals' current environments to provide a sense of escape; however, Kaplan (1995) noted that this environment does not need to be physically away but may simply mean

a change of view or direction of gaze. The second component *extent* highlights that an environment must be rich in interesting stimuli that it constitutes itself as physically different from the individual's current environment, and contains enough interesting information to hold the indirect attention. The third, *compatibility* acknowledges that there must be coherence between an individual's preference and what the environment offers or demands. If all these components are met within a natural environment, an individual with post-traumatic stress symptoms may benefit from a nature-based experience as the environment is viscerally engaging, and does not require the use of high levels of cognitive capacity to remain attentive.

Overall, information provided by ART coupled with the theories of SRT suggest that nature provides a resource which may be beneficial to individuals with post-traumatic stress symptoms. Unlike other interventions that involve higher cognitive capacities to perform, the viscerally engaging features of natural environments provide individuals with feelings of safety and security. As fMRI results have shown, when viewing natural environments with involuntary attention, the human brain does not respond by activating a fear response (Kim et al., 2010). Rather, the human brain is likely to respond positively with feelings of calmness and security due to a biological predisposition to these natural environments that has evolved with the human species.

Chapter 2

Literature Review

Research exploring the psychophysiological stress reducing effects of nature remained generally untested until a landmark study by Ulrich (1981). In this study, unstressed adult participants viewed three different sets of coloured slides containing images of nature with water, nature with vegetation, or an urban environment. Self-report measures gathered information on affective changes in participants while electrocardiographs (ECG) and electroencephalographs (EEG) measured physiological measures of stress by heart rate and brain wave activity respectively. Ulrich (1981) reported that although there was no difference in heart rate across the different conditions, EEG results indicated that participants were more wakefully relaxed as evidenced by higher alpha wave amplitudes when natural environments were being viewed. Results from the psychological measure indicated that self-reported fear arousal increased after viewing urban environments and decreased after viewing the natural environments. The author proposed these findings provided evidence that natural environments are effective in producing physiological feelings of calmness and improving positive emotional states.

Ulrich conducted further studies that explored nature's reduce stress reducing effects. In his next experiment, adult participants watched a stressful movie that produced autonomic arousal as evidenced through measures of heart rate, skin conductance, and blood pressure (Ulrich et al., 1991). Following the movie, participants were randomly assigned to one of six conditions for the recovery period where they watched a colour video with congruent sound of either an urban or a natural environment. The researchers reported that results from physiological measures taken throughout the recovery phase indicated that participants who watched a natural environment had a more rapid and complete physiological recovery from

the stress-inducing video. Pre-post psychological measures also indicated a reduction in aggression and an increase in positive thoughts in the nature movie group. Ulrich et al. (1991) concluded that natural environments are beneficial in reducing stress and increasing positive effect in individuals in a temporarily induced hyperaroused state.

Since Ulrich's early research a number of studies have explored the beneficial effects of nature exposure. A systematic review and meta-analysis conducted by Bowler, Buyung-Ali, Knight, and Pullin (2010) collated and synthesised findings from 25 studies exploring the role of natural environments on wellbeing and health. Effect size results calculated in the study indicated that studies have shown that natural environments can improve negative emotions such as anger, fatigue, and sadness (Bowler et al., 2010). Findings from across the studies in regards to physiological measures, such as blood pressure and cortisol indicated no significant effect. However, Bowler et al. (2010) noted that the physiological results are based on only four studies, which limited the significance of the findings. The lack of research examining objective physiological outcomes led the authors to suggest further research was needed to examine these findings further. Furthermore, the review excluded any studies that used simulated experience of nature, such as videos or images, which may also have potential stress reducing effects.

Research since the review by Bowler et al. (2010) has further explored the psychophysiological benefits of nature, and has highlighted that an outdoor experience may not be always be needed to obtain its stress reducing benefits. Alvarsson, Wiens, and Nilsson (2010) found that listening to nature sounds in an induced stressed state facilitated recovery of the SNS following a stressful task. In this study, healthy adult participants undertook a stressful arithmetic task prior to being exposed to sounds from nature, traffic noise, or ambient neighbourhood sounds for four minutes. Skin conductance level (SCL) was used as a measure of SNS activity while high-frequency heart rate variability (HF HRV) signified the

presence of PNS activity. Results indicated that SCLs were lower, and that recovery time following the stressor was faster, in the nature sound condition in comparison to the environmental and ambient noises. Results from HF HRV data did not indicate a difference among the conditions on PNS activity. Alvarsson et al. (2010) concluded that exposure to natural sounds is beneficial for physiological recovery of the SNS following an induced stress.

Largo-Wight, O'Hara, and Chen (2016) found similar results in a recent study exploring nature sounds and stress reduction. Baseline measures of muscle tension, pulse rate, and self-reported stress were compared to measures taken after adult participants listened to either nature sounds, classical music, or waited in silence for a duration of 15-minutes. Results indicated that listening to nature sounds of ocean waves was effective in reducing both objective physiological and subjective self-reported levels of stress. These findings were dissimilar to other sound conditions contrary to research that reported a reducing in stress after listening to classical music (Chafin, Roy, Gerin, & Christenfeld, 2004; Linnemann, Ditzen, Strahler, Doerr, & Nater, 2015). The authors concluded that even brief exposure to natural sounds has potential benefit in reducing both objective and subjective levels of stress.

A study by Gladwell et al. (2012) used images of natural and built environments to explore ANS activity whilst participants viewed different environments. While seated in a laboratory setting, adult participants viewed 18 slides containing images of either natural or built environments while measures of the ANS activity were taken. The results from the measures of HRV and barometer receptor activity showed an increase in PNS activity, which indicated that participants were less stressed while viewing the natural environments in comparison to the built environments. The authors suggested these results provide evidence that simply viewing images of nature increase PNS activity.

The previous studies discussed have provided evidence that experiencing nature through either visual or auditory stimuli may contribute to the activation of stress reducing mechanisms. The development of virtual reality technology provides another medium to experience nature that incorporates both visual and auditory stimuli, and offers a realistic sensory experience. Annerstedt et al. (2013) used a virtual reality simulation of nature to produce the experience of being in a natural environment. Adult participants undertook a virtual reality experience of the Trier Social Stress Test (TSST) that required participants to complete speech and mathematical problems whilst being watched by an audience. This experience induced physiological stress by activating the HPA axis and SNS as evidenced through increased salivary cortisol and heart rate. Following the TSST, participants were then assigned to one of three conditions for the recovery period: a virtual reality simulation of a forest with congruent nature sounds, virtual reality simulation of a forest without congruent sounds, or recovery in the laboratory with no virtual reality experience. Physiological measures taken after the stress test and during the recovery period highlighted the difference between conditions. Participants that recovered in the virtual reality forest with sound condition had increased HF HRV, indicating increased PNS activity, in comparison to participants that recovered in the other two conditions. The authors of the study contrasted their results to those of Alvarsson et al. (2010) outlined earlier that found decreased SNS activity without activation of PNS activity following a stressor when listening to nature sounds alone. Annerstedt et al. (2013) suggested a possible enhanced sense of reality when both sound and visual nature stimuli are present, which may contribute to the activation of the PNS. This is an important consideration to take into account when considering a simulated nature experience as a potential stress reducing intervention.

Similar stress reducing benefits have also been found in studies that used real natural environments as the nature-based experiences. Recent studies by Bratman, Daily, Levy, and

Gross (2015) and Gidlow et al. (2016) explored the psychophysiological benefits of walking through natural environments. Both used pre-post tests measures and a comparison condition where participants walked in an urban environment. A focus on natural environments and their attention restorative properties was also explored in these studies.

Bratman et al. (2015) used a randomised controlled trial to compare changes in effect and cognitive functioning after healthy adult participants walked through either a natural or urban environment. Pre-post test results demonstrated a significant reduction in anxiety and a small reduction in rumination for participants who walked through a natural area. Similar results were not found for the participants who walked through the urban area. Results from a working memory task also demonstrated an improvement in cognitive functioning for the participants in the nature walk condition but not in the urban walk condition.

Gidlow et al. (2016) reported similar improvements in their repeated measures experiment that involved a 30-minute walk through three different environments: urban, natural, or natural with water. Overall, the authors concluded that results from self-reported mood highlighted the salutogenic effects of walking demonstrated by an improvement across all environments (Gidlow et al., 2016). Furthermore, all conditions reported decreased salivary cortisol; however, results across environments differed according to cognitive functioning. Both natural environments demonstrated improved cognitive functioning from baseline to 30-minutes post walk whereas performance had decreased below baseline scores following the urban walk. Both this study and that by Bratman et al. (2015) provide evidence for both theories related to nature. An improvement in positive effects, following a walk in nature is produced through the stress reducing effects of nature contact, while a replenishment of cognitive functioning is facilitated through nature's ability to use the individuals' indirect attention, which allows taxed direct attention to recover.

The previous research has demonstrated that nature-based experiences can enhance feelings of relaxation in healthy individuals and promote recovery after an acute induced stress. But research has also shown nature's effectiveness in reducing stress caused by physical and mental health issues. This research is outlined below.

Hypertension is a physical health disorder with a key symptom of increased blood pressure. Evidence has shown that hypertension is common among individuals who experience chronic psychosocial stress (Sparrenberger et al., 2009) and is prevalent among individuals with PTSD (Balint et al., 2015). An increasing number of research studies, exploring the role of the SNS in hypertension (DiBona, 2013), suggest that nature's ability to reduce SNS activity and increase PNS activity may be effective in treating this disorder.

Song et al. (2015) explored how brief walks in a forest environment may affect SNS and PNS activity in adults with hypertension. In this study, participants walked through a natural environment and an urban environment to explore the effects that the different areas had on the participants. Walking speed and energy expenditure was kept equal between the two courses. Results showed that heart rate as a measure of SNS activity was significantly lower, and HF HRV as a function of PNS activity, was significantly higher as participants walked through the natural environment. Self-report measures also demonstrated increased feelings of comfort and relaxation and decreased tension and anxiety following the walk in the natural environment.

Nature experiences also appear to be effective in supporting psychophysiological recovery for individuals with exhaustion disorder. Research by Sonntag-Ostrom et al. (2014) explored the effects of visiting a forest environment in comparison to an urban environment for 20 female adult participants with exhaustion disorder. Participants spent 90-minutes sitting in these environments. Pre-post results from a cognitive task found increased attention capacity following a visit to the forest environment, while results indicated a decrease

following a visit to an urban environment. Participants' self-report measures indicated their mood was more relaxed and clearheaded, and physiological measures of heart rate and diastolic blood pressure indicated a decrease in physiological stress when in the forest environments as opposed to the urban environment. The authors concluded that visiting forest environments may be beneficial in reducing mental, physical, and cognitive fatigue in individuals whose disorder is due to chronic stress (Sonntag-Ostrom et al., 2014).

The stress reducing effects of interacting with natural materials, such as plants and flowers, has also been explored by measurements of ANS activity. M.Lee, J.Lee, Park, and Miyazaki (2015) used blood pressure and heart rate measures to evaluate SNS functioning when participants were transplanting indoor plants into pots. A computer task was used as a comparison activity. The results demonstrated a significant difference in SNS functioning during the two tasks as blood pressure and heart rate variability increased during the computer task, and decreased during the plant-tending task.

Horticultural therapy (HT) has been recommended as an effective therapy for individuals with post-traumatic stress symptoms (Detweiler et al., 2010). Kotozaki (2013) used a HT intervention for elderly female participants that reported stress after experiencing an earthquake in Japan. Self-report measures of post-traumatic stress symptoms, depression, quality of life, and post-traumatic growth taken at baseline, post-intervention, and at a two-month follow up point explored the subjective benefits of the intervention. Salivary cortisol was used as an objective measure of stress. Results demonstrated the intervention was effective in reducing symptoms of post-traumatic stress and improving post-traumatic growth. The authors reported that the intervention appeared to be effective in reducing depression and improving quality of life among participants. Results also indicated a reduction physiological stress as evidenced through a reduction of cortisol from pre- to post-intervention.

Nature-based outdoor recreation interventions have been explored for their efficacy in treating individuals with PTSD. Vella, Milligan, and Bennett (2013) explore the effectiveness of a two-day, three-night outdoor recreation intervention for veterans with PTSD. The intervention involved fly-fishing and interacting with individuals with similar life experiences. The authors were interested in evaluating the psychological stress reducing effects of the intervention and used repeated measure of self-report scales at baseline, on the last day of the intervention, and at a six-week follow up point. Results illustrated the intervention's effectiveness in reducing self-reported levels of negative moods, depression, anxiety, and perceptual stress. Participants also reported an improvement in somatic symptoms of stress and sleep quality. However, although results were not as significant at follow-up than they were directly after the intervention, improvements were still made in comparison to baseline data.

Children and Nature

The use of nature-based interventions to reduce stress and hyperarousal in children is currently an underexplored research area. Cross-sectional studies exploring correlations between nearby nature and indicators of stress support the idea that nature can be a potential buffer for stress during childhood. Wells and Evans (2003) explored whether nature nearby to children's residence served as a buffer to stressful life events. Researchers interviewed mothers of children around the age of nine years old, who resided in a rural area, to obtain information about the number of stressful life events their child has encountered, their child's psychological distress, and the naturalness of their residential area. Naturalness of the residence included the material of their yard, the amount of indoor plants, and the extent of naturalness that can be viewed from their residence's windows. Children were asked to respond to questions regarding their perceived wellbeing. As hypothesised, increased exposure to stressful life events negatively affected children's psychological distress.

However, the impact of stressful life events was moderated by the amount of nearby nature; children who had higher quantities of nature close by reported less psychological distress after experiencing a stressful life event. The authors propose that nature is a potential mechanism that can buffer the life stresses experienced by children (Wells & Evans, 2003). They explain two possible explanatory mechanisms. Firstly, natural areas may provide children with more opportunities to acquire social support as they draw children together and foster greater connections. The second explanatory mechanism proposed was in line with ART. The authors suggest that greater amounts of nature exposure allow children more clarity in their thinking enabling them to resist the proclivity to react negatively and to cope more effectively when faced with a stressful life event.

Markevych et al. (2014) used information from two German birth cohort studies for a cross-sectional analysis of the naturalness of children's residences and an objective physiological measure of stress. Information from a total 2,078 10-year-old children gathered data regarding levels of vegetation, using satellite images and the cohorts' blood pressure. After controlling for possible confounding variables, such as social economic status and potential environmental stressors (noise, pollution, temperature, altitude and urbanisation), results indicated that children living in residences with low and moderate amounts of greenness had higher blood pressure than children living in areas with high greenness. The authors explained these results in relationship with the psychoevolutionary theory developed by Ulrich (1981; 1983), and proposed that contact with nature increases PNS and decreases SNS activity due to our extended period of evolution in natural areas eliciting better physiological and possibly psychological adaptation (Markevych et al., 2014).

In addition to their local residence, children spend a large quantity of time in their school environment. Kelz, Evans, and Roderer (2013) used a quasi-experimental research design to explore the potential psychophysiological benefits of redesigning a schoolyard to

include more natural elements. Pre-post test analysis explored the changes in 13 – 15-year-old students' blood pressure, subjective wellbeing, and executive function due to the experimental schools' redesigned schoolyard. Comparisons were made to two control schools that were demographically similar and within close physical proximity. Results illustrated a significant decline in blood pressure following the redesign whereas similar results were not reported from the control schools. Students at the experimental school demonstrated an improvement in executive function when comparing pre-post test scores on the Attention Networking Test (ANT) task. As hypothesised by the authors, subjective wellbeing increased in the experimental school whereas scores at the control schools remained consistent across pre-post time points. The authors suggested these findings were similar to adult research, which has shown that nature can reduce stress and improve wellbeing (Kelz et al., 2013).

Many schools are fortunate enough to have access to natural areas in their schoolyards or attend schools where programmes include interaction with nature. Chawla, Keena, Pevec, and Stanley (2014) documented students' experiences of their interaction with nature during the school day. Three different school aged groups were studied in this research: students aged 6-12 years old, who played in woodland areas during recess; students aged 9-13 years old, who used natural habitats in their school during regular lessons; and adolescents aged 15-19 years old that took part in a school-based gardening programme. The authors used the results from observations and semi-structured interviews to analyse students' experiences in the natural areas. Students in the youngest sample studied, whilst less able to express their emotions, due to developmental differences, made remarks about the woodland area as a place where they feel they can relax and be themselves (Chawla et al., 2014). Parents and school staff contrasted the safe and carefree nature of the woods to the social and academic pressures of the learning space and articulated the benefits of the environment during recess for their children and students. Students who experienced the natural environment during

their class's writing and science programme reported feelings of peace, calmness, and relaxation as well as a relief from worry during their time in the natural environment. The older students could better articulate their experiences with the gardening programme. Open-ended interviews allowed the researcher to identify frequency counts of key words that expressed feelings of calmness, happiness, and relaxation. These words were used by over half of the respondents, and reasons for their use suggested by the author was that the children were able to self-reflect and focus during their time in the garden (Chawla et al., 2014). Children and adults perception of the woods area used during recess as a "safe haven" and "safe haven" (Chawla et al., 2014, p.10) reflects Ulrich's psychoevolutionary theory (1981;1983), which suggests increased feelings of calmness and wellbeing in natural spaces. The authors also reflected on their findings in relation to ART as all but one of the students reported improved concentration after gardening.

Natural areas may not always be available in schools to provide students with restorative experience and therefore, areas outside of the school grounds may need to be utilised. A study by Berto, Pasini, and Barbiero (2015) explored the restorative value of different environments on children aged 9-11 years old. Three different activities were completed in a repeated measures experiment: a walk in an alpine woods, a mindfulness activity in the children's learning space, or a free time activity in the schoolyard which was a mix of built and natural environment. Following each of the activities, students completed cognitive tasks that measured attentional performance, and self-report measures of the participants' perceived restorative value of the different environments. Ten minutes after the completion of the activity physiological measures of heart rate and blood pressure were also taken. Overall, results illustrated greater attentional capacity following the alpine woods activity in comparison to the mindfulness activity and the free time activity. The children in the study also rated the alpine woods environment as the most restorative. Physiological

measures demonstrated that blood pressure and heart rate were the highest following the free play activity; however, there was no difference in the physiological measures between the alpine walk and the mindfulness activity. The authors highlighted the findings of improved attentional capacity following the alpine walk in relation to ART, and emphasised the value of natural environments for children (Berto et al., 2015).

Other research exploring the benefits of nature for children has focused on individuals with reported problem behaviours. Roe and Aspinall (2011) explored the psychological benefits of attending an outdoor education setting in comparison to a regular schooling setting. The authors were interested in exploring whether 11-year-old children identified by their teachers as having so-called difficult behaviour would benefit more than children of the same age who did not exhibit problem behaviours. A pre-post design gathered information, regarding changes in self-reported energy, stress, anger, and hedonic tone, following a day in each of the two different environments. Overall, the results highlighted a significant positive change in emotion across all participants, following a day in the forest school environment. Furthermore, children identified as having difficult behaviours experienced greater improvements in energy, hedonic tone, and stress, than the regular behaviour group. A reduction in self-reported levels of anger was also reported for the behaviour group. Roe and Aspinall (2011) highlight the implication of these findings for children with challenging behaviours: spending time in nature can be especially beneficial for promoting improved mood and reducing negative feelings that can lead to problem behaviours.

Current literature highlights that post-traumatic stress symptoms in children share similar features to attention deficit hyperactivity disorder (ADHD) (Malarbi, Muscara, & Stargatt, 2016). In particular, both have impairment in concentration and attention, and restlessness as common symptoms. A study by Faber, Taylor, and Kuo (2009) explored the benefits of walking in a natural environment for children aged seven to 12-years-old that had

been diagnosed with ADHD. Participants in the repeated measures study experienced a 20-minute guided walk through three different environments: a city park, a residential area, and a downtown area. Children were given a task to complete prior to their walk to induce some degree of attentional fatigue. Following the walk, children completed a cognitive task to ascertain their level of concentration. Results demonstrated that, in comparison to the two urban areas (downtown and residential) the participants' concentration was significantly improved, following the walk through the park. Faber, Taylor, and Kuo (2009) discussed their findings in relation to ART, and suggested that time spent in a natural environment may provide relief from overworked directed attention, allowing neurocognitive resources to replenish resulting in improved concentration.

Taking time out of the school day to experience time in nature may not always be possible, and schools may need to utilise the resources they have to capitalise on the benefits of interaction with nature. Swank, Shin, Cabrita, Cheng, and Rivers (2015) explored the effect of a nature-based, child-centred play therapy (NBCCPT) intervention for four children aged between six and eight years old that have exhibited problem behaviours. The intervention consisted of the regular Child-Centred Play Therapy (CCPT) within an alternative setting to the regular indoor office. The NBCCPT took place on school grounds and used natural materials instead of regular play materials normally used during therapy sessions. Although results were mixed among the four participants, two participants exhibited positive changes in observed learning space behaviours during the seven-week intervention. Interestingly, both these participants had a diagnosis of ADHD. One of these two participants also demonstrated an increase in on-task classroom behaviours. Moreover, the results of observations made three weeks following the conclusion of the intervention demonstrated maintenance of the positive behavioural change. Swank et al. (2015) report that while their study is the first to explore NBCCPT, it provides an alternative approach to CCPT that in its

regular setting may be intimidating for some children. Incorporating a natural element may help children to relax and become more open to communicating with the therapist.

Summary of Nature-Based Intervention Studies

There were 18 experimental studies included in the preceding literature review. Below, these studies are summarised according to the participants, research design, measures, and format of the intervention. Details about each studies participants and research design are summarised in Table 2. Details regarding the measures and format are summarised in Table 3.

Table 2: Experimental Studies Exploring the Psychophysiological Benefits of Nature: Aim and Methodology

Citation	Aim	Design and Participants	Intervention	Control/Comparison
Ulrich (1981)	To explore the physiopsychological effects of viewing picture slides of natural environments in comparison to urban environments.	Experimental, within subjects design. Participants N=18, ages = 20-27 years, no reported psychological diagnoses.	Participants sat in a comfortable armchair while colour images of natural environments were projected onto a wall, two metres from their chair. Instructions given informed them to pay attention to the screen and not to let their eyes wander. Sixty slides were projected, each for duration of 25 seconds.	Viewing colour images of urban environments.
Ulrich, Simons, Losito, Fiorito, Miles, and Zelson (1991)	To explore the stress reducing effects of nature slides as opposed to slides of urban or built environments.	Experimental, between groups design. Participants N=120, Mean age not provided, all college students.	Participants sat in a comfortable armchair while they watched colour videos on a 19" monitor. The videos portrayed environments with natural features, and went for duration of 10-minutes each.	Watching a colour videotape of an urban environment.
Faber, Taylor, and Kuo (2009)	To explore the effects of different environments on the attention of children with ADHD.	Experimental, within subjects design. Participants (N=17), mean age 9.23 years. All diagnosed with ADHD.	Participants walked along a designated track for 20-minutes in a park environment with a guide. Conversations between the participant and the guide were kept to a minimum.	Walking with a guide through 1) downtown and 2) a residential area.

Citation	Aim	Design and Participants	Intervention	Control/Comparison
Alvarsson, Wiens, and Nilsson (2010)	To compare the effects of different sounds on the physiological recovery of participants after an induced psychological stress.	Experimental, within subjects design. Participants (N=40) mean age = 27 years. All university students with normal hearing.	Participants listened to four minutes of recorded nature sounds through a set of headphones whilst seated in a soundproof room.	Listening to 1) road traffic noise at high pressure (80dB), 2) road traffic noise at low pressure (50dB), and 3) listening to ambient noises (40dB).
Roe and Aspinal (2011)	To explore the restorative outcomes for students after spending time in a forest school compared to conventional school.	Experimental, within subjects design. Participants (N =18) mean age 11 years. Participants were divided into two groups based on teacher-reported behaviour (<i>good</i> behaviour N=6, <i>bad</i> behaviour N=12).	Participants spent time in an outdoor education setting (forest school). The authors did not outline any particular activities undertaken in this intervention.	Participants' regular school.
Gladwell, Brown, Tarvainen, Kuoppa, Pretty, Suddaby &	To explore ANS functioning in response to viewing both built and natural	Experimental, within subjects design. Participants N=35, mean age 39.7 years.	Participants sat in a semi-supine position in a laboratory setting while 18 slides of natural scenes were projected in front of them. Participants were asked to	Viewing slide images of built environments.

Citation	Aim	Design and Participants	Intervention	Control/Comparison
Sandercock (2012)	environments.	No reported preexisting psychological diagnosis.	imagine they were in the environment. The slideshow lasted for five minutes.	
Annerstedt, Jönsson, Wallergård, Johansson, Karlson, Grahn, Hansen, and Währborg (2013)	To explore the effects of a virtual reality nature experience on physiological and subjective measures of stress.	Experimental, between groups design. Participants N=30 (all male), mean age = 27.7, no reported psychological diagnoses.	Participants viewed a virtual reality natural environment with or without congruent sound, whilst seated in a comfortable chair for 40 minutes.	Sitting in a laboratory with no virtual reality nature during recovery period.
Kelz, Evans, and Roderer (2013)	Explore the effects of a renovated schoolyard that increased contact with nature on students' physiological stress, wellbeing, and executive functioning.	Quasi-experimental, between groups design. Experimental school (N=72), and two control schools (N=61). Participants in both experimental and control schools aged between 13 and 15 years with a mean age of 14.4 years	The experimental school received a redesign of their schoolyard to include more greenery (shrubs and pot plants), outdoor seating, outdoor play equipment, and a drinking fountain.	Two schools in close proximity that did not receive a redesigned schoolyard.
Kotozaki	To explore the	Experimental,	The HT intervention consisted of	Stress control education for the

Citation	Aim	Design and Participants	Intervention	Control/Comparison
(2013)	effectiveness of horticultural therapy (HT) in reducing psychological and physiological measures of stress related to experiencing a natural disaster.	between groups design. Participants (N = 39) were elderly women aged between 60-75 years who experienced symptoms of post-traumatic stress following an earthquake in Japan.	eight weekly sessions that went for duration of 60 minutes each. The first two sessions involved interactive lectures and horticultural training, while the remaining six sessions comprised of lessons in horticulture skills such as tending to and looking after gardens. In addition, participants were also required to attend to their own gardens at home for 15 minutes a day.	same duration as HT intervention.
Vella, Milligan, and Bennett (2013)	To evaluate the effectiveness of an outdoor recreation intervention in reducing symptoms of stress associated with PTSD in veterans.	Quasi-experimental, within subjects design. Participants (N=74) mean age of 47.27 years. All participants were veterans who had served in a foreign country that had a diagnosis of PTSD.	Participants took part in a 3-night outdoor recreation retreat. They were taught the technique of fly-fishing by trained professionals and over the three days, spent 16 hours fly-fishing from boats on a river. This intervention also provided the opportunity to interact with other veterans who have had similar life experiences in a natural environment setting.	N/A
Sonntag-Ostrom, Nordin, Lundell, Dolling, Wiklund,	To investigate the perceived restorativeness and psychophysiological	Experimental, within subjects design. Participants (N=20)	Participants were transported from their homes to a natural environment (forest) with the test leader, who avoided any	Sitting in an urban environment.

Citation	Aim	Design and Participants	Intervention	Control/Comparison
Karlsson, Carlberg, and Järvholm (2014)	responses of urban and natural environments on individuals with exhaustion disorder.	mean age 41.6. All participants had a diagnosis of exhaustion disorder.	therapeutic discussions. Upon arrival at the forest, participants spent 10 minutes becoming accustomed to the area. They then sat in the forest with their back against an object (tree or rock) for a period of 40 minutes.	
Berto, Pasini, and Barbiero (2015)	To explore children's opinion about the restorativeness of natural vs urban environments, and whether environments differentially impacted attentional performance. Also to explore how children feel connected to nature.	Experimental, within subjects design. Participants N=48, ages 9-11 years, no reported psychological diagnoses.	A teacher accompanied children into an alpine wood nearby to their school for 90 minutes. The teacher attempted to simulate the children's senses by drawing their attention to different aspects of the woods.	1. Mindfulness silence activity in the learning space. 2. Free play in their schoolyard.
Bratman, Daily, Levy and Gross (2015)	Explore the impact of nature experience on affect, cognition, and changes in	Experimental, between groups design. Participants N=60, mean age 22.9, no	Participants completed a 50-minute walk along a paved path through a natural environment with dispersed shrubs and trees. Participants were advised by a	Walking through an urban environment.

Citation	Aim	Design and Participants	Intervention	Control/Comparison
	anxiety.	reported psychological diagnoses.	research assistant at the beginning of the walk to take 10 photographs of “whatever captured their attention” along the walk.	
Gidlow, Jones, Hurst, Masterson, Clark-Carter, Tarvainen, Smith, and Nieuwenhuijsen (2016)	Compare the effects of walking in an urban, green or blue environment.	Experimental, within subjects design. Participants N=38, mean age=40.9 years, no reported psychological diagnoses.	Participants completed a 30-minute walk through natural environments that were either green – in a park environment, or blue – next to a canal. The accompanying research assistant provided no social interactions with the participants. Both environments had low noise levels, and visits were made on days with temperate weather conditions.	Walking through an urban environment.
Lee, Lee, Park, and Miyazaki (2015)	To explore ANS reactivity to contact with indoor plants.	Experimental, within subjects design. All male participants (N=24), mean age of 24.9. No participants reported a history of physical or psychiatric illness.	In greenhouse room, participants were required to tend to and transplant <i>Peperomia dahlstedti</i> , a common indoor plant.	Completing a computer word processing task.

Citation	Aim	Design and Participants	Intervention	Control/Comparison
Song, Ikei, Kobayashi, Miura, Taue, Kagawa, Li, Kumeda, Imai, and Miyazaki (2015)	To explore the effects of forest walking on ANS functioning in individuals with hypertension.	Experimental, within subject design. Participants (N=20) all males with a mean age of 58 years. All participants had hypertension, or were in a prehypertensive range measured via blood pressure.	An experimenter from the study guided participants through a predetermined course. The course took 17 minutes to complete, and led them through a flat forest environment.	Walking through an urban environment.
Swank, Shin, Cabrita, Cheung, and Rivers (2015)	To explore the effectiveness of NBCCPT with children identified as having behavioural problems.	Quasi-experimental, single-subject (ABA) design. Participants (N = 4) Participant 1: 8-year-old girl, ADHD diagnosis. Participant 2: 6-year-old boy, ADHD diagnosis. Participant 3: 6-year-old boy. No diagnosis; teacher-reported problem behaviours.	Participation in a NBCCPT twice weekly for seven weeks. Each session went for a duration of 30 minutes. NBCCPT aligned with regular CCPT guidelines with modifications to include a natural environment where natural materials were used instead of toys.	Baseline measures.

Citation	Aim	Design and Participants	Intervention	Control/Comparison
		Participant 4: 6-year-old girl. No diagnosis; teacher-reported problem behaviours.		
Largo-Wight, O'Hara, and Chen (2016)	To explore the psychophysiological effects of listening to nature sounds for a brief duration.	Experimental, between groups design Participants (N=40), all college students with no reported psychological disorder or preexisting stress disorder.	Participants sat at a desk facing a plain white wall whilst they listened to the nature sound of ocean waves for 15-minutes.	1. Listening to classical music. 2. Silence.

Participants. There were 18 studies that explored the psychophysiological effects of a nature-based intervention (Table 2). Across all studies was a total of 778 participants, of which 558 were adults and 220 were children aged six to 15-years-old. In the 13 adult studies: nine studies included healthy participants, with no reported psychological or stress related disorder (Ulrich, 1981; Ulrich et al., 1991; Alvarsson et al., 2010; Gladwell et al., 2012; Annerstedt et al., 2013; Bratman et al., 2015; Gidlow et al., 2016; Lee et al., 2015; Largo-Wight et al., 2016); two studies included participants with a diagnosis of PTSD (Kotozaki, 2013; Vella et al., 2013); one study included participants with exhaustion disorder (Sonntag-Ostrom et al., 2014); and one study included participants with hypertension (Song et al., 2015). In the five studies with child participants: two included healthy participants, with no reported psychological or stress related disorder (Kelz et al., 2013; Berto et al., 2015); one included participants with a diagnosis of ADHD (Faber Taylor, & Kuo, 2009); one study included both healthy participants and individuals with teacher-reported problem behaviour (Roe, & Aspinall, 2011); and one study included both participants with ADHD and individuals with teacher-reported problem behaviour (Swank et al., 2015)

Design. Fifteen studies used an experimental design to explore the effectiveness of nature-based interventions (Table 2). Of these 15 studies, eight used a within subjects design (Faber Taylor, & Kuo, 2009; Roe & Aspinall, 2011; Gladwell et al., 2012; Sonntag-Ostrom, 2014; Berto et al., 2015; Gidlow et al., 2016; Lee et al., 2015; Song et al., 2015) and seven used a between-subjects design (Ulrich, 1981; Ulrich et al., 1991; Alvarsson et al., 2010; Annerstedt et al., 2013; Kotozaki 2013; Bratman et al., 2015; Largo-Wight, 2016). The remaining three studies used a quasi-experimental design of which two used a within subjects design (Vella et al., 2013; Swank et al., 2015) and one used a between subjects design (Kelz et al., 2013)

Measures. A wide range of physiological and psychological measures of stress were used across these studies (Table 3). Furthermore, there was a difference across studies in regards to the points in which measures were taken in relation to the intervention. These are outlined below.

Thirteen studies included a measure of physiological stress using one or more of the following measures: heart rate, blood pressure, skin conductance, T-wave amplitude, HRV, muscle tension, and cortisol. Eight studies included a measure of heart rate: six studies measured participants' heart rate continuously over the duration of the intervention (Ulrich, 1981; Ulrich et al., 1991; Gladwell et al., 2012; Annerstedt et al., 2013; Song et al., 2015; Sonntag-Ostrom et al., 2014); one measured participants' heart rate both pre- and post-intervention (Largo-Wight et al., 2016); and one measured participants' heart rate post-intervention only (Berto et al., 2015). Six studies included blood pressure as a measure of physiological stress: four measured participants' blood pressure continuously during the intervention (Ulrich et al., 1991; Gladwell et al., 2012; Sonntag-Ostrom et al., 2014; Lee et al., 2015); one measured participants' blood pressure pre- and post-intervention (Kelz et al., 2013); and one measured participants' blood pressure post-intervention only (Berto et al., 2015). Heart rate variation and skin conductance were both measured across the duration of the intervention in six (Gidlow et al., 2016; Song et al., 2015; Lee et al., 2015; Annerstedt et al., 2013; Gladwell et al., 2012; Alvarsson et al., 2010) and two (Ulrich et al., 1991; Alvarsson et al., 2010) of the studies respectively. One study (Annerstedt et al., 2013) measured T-wave amplitude across the duration of the intervention. Two studies measured muscle tension either during the intervention (Ulrich et al., 1991) or pre- and post-intervention (Largo-Wight et al., 2016). Three studies measured participants' salivary cortisol levels either throughout the intervention (Annerstedt, 2013), or pre-post intervention and at follow-up (Kotozaki, 2013; Gidlow et al., 2016).

Thirteen studies used a self-report measure to gather information about the psychological benefits of nature-based interventions. Five studies measured participants' self-reported mood either pre-post intervention (Ulrich, 1981; Roe & Aspinall, 2011), pre-post intervention and follow-up (Gidlow et al., 2016) or post-intervention only (Sonntag-Ostrom et al., 2014). Four studies measured state affect using pre-post intervention measures (Ulrich, 1981; Ulrich et al. 1991; Annerstedt et al., 2013; Bratman et al., 2015). Largo-Wight et al. (2016) and Vella et al. (2013) measured self-reported stress both pre- and post-intervention. Vella et al. (2013) also measured self-reported stress at a follow-up time point. Three studies measured the participants' perceived restoration of different environments either pre- and post-intervention (Kelz et al., 2013), or post-intervention only (Berto et al., 2015; Gidlow et al., 2016). Berto et al. (2015) measured participants' connectedness to nature post-intervention only. Other pre-post self-report measures included wellbeing (Kelz et al., 2013), rumination (Bratman et al., 2015), and comfort and relaxation (Lee et al., 2015). Two studies gathered data using self-report measures pre- and post-intervention and at a follow-up point (Kotozaki, 2013; Vella et al., 2013). Kotozaki (2013) used self-reported depression, post-traumatic growth, and quality of life, while Vella et al. (2013) measured self-reported post-traumatic stress symptoms, psychological distress, and sleep quality.

Additional measures used included cognitive performance tasks and observable behaviours. Six studies used a cognitive performance task either pre-post intervention (Bratman et al., 2015; Gidlow et al., 2016; Kelz et al., 2013) or post-intervention only (Faber, Taylor & Kuo, 2009; Sonntag-Ostrom et al., 2014; Berto et al., 2015). One study used a measure of the participant observable behaviours (Swank et al., 2015).

Format of nature-based interventions. Across the 18 studies, the interventions varied in the duration and type of nature-based experience. These interventions have been

categorised as being either direct nature, surrogate nature, or simulated nature. Below the studies are categorised, and their intervention is briefly described.

Direct nature. Eight studies involved interventions that involved direct nature exposure. Five of these studies involved walking through nature for a duration of either 17 minutes (Song et al., 2015), 20 minutes (Faber Taylor, & Kuo, 2009), 30 minutes (Gidlow et al., 2016), 50 minutes (Bratman et al., 2015), or 90 minutes (Berto et al., 2015). One study involved sitting in a natural environment for 40 minutes (Sonntag-Ostrom et al., 2014). In the study by Roe and Aspinall (2011) participants spent a day at “forest school” instead of their regular school environment; however, the authors did not detail the activities or duration involved in this intervention. The intervention in the study by Vella et al. (2013) involved a three-day outdoor recreation retreat. A main feature of this intervention, outlined in the article, was that over the three-day intervention, participants spent 16 hours fly-fishing on a nearby river.

Surrogate nature exposure. Surrogate nature interventions are defined as those that involve interaction with an element of nature, such as plants or other natural materials, but not within a natural environment (Berto, 2014). Four studies involved a surrogate nature intervention. The intervention in the study by Swank et al. (2015) involved an adaptation of Child-Centred Play Therapy (CCPT) where natural materials replaced regular play toys used within CCPT, and session took place outdoors within the school grounds instead of a designated indoor area. This Nature-Based CCPT (NBCCPT) intervention involved two 30-minute sessions per week for seven weeks. Two studies involved participants tending to plants as the nature-based intervention. In the study by Kotozaki (2013), participants took part in an HT intervention that involved weekly 60-minute sessions for eight weeks, whereas the study by Lee et al. (2015) required participants to tend to indoor plants for the duration of 15 minutes. Interaction with surrogate nature was less prescribed in the quasi-experimental

study by Kelz et al. (2013) where the intervention involved the redesign of the participants' schoolyard to include more natural materials, such as trees and shrubs. Participants experienced the naturalised schoolyard for seven weeks before post-intervention measures were taken.

Simulated nature exposure. Six studies used videos, images, sounds, or a combination of these media to replicate a nature-based experience. In two studies, participants viewed images of nature on slides for a total of 26 minutes (Ulrich, 1981) in one instance and for five minutes in the other study (Gladwell et al., 2012). Two studies required participants to listen to nature sounds for four minutes (Alvarsson et al., 2010) and 15 minutes (Largo-Wight et al., 2016). One study used a nature video with congruent sound that participants watched and listened to for 10 minutes (Ulrich et al., 1991). Annerstedt et al. (2013) used a virtual reality intervention that involved a realistic experience of nature involving both visual and congruent auditory input. Participants in this study experienced the virtual reality environment for 40 minutes.

Summary of Effectiveness across Studies

Calculation of an effect size allows researchers to determine the significance of results that an intervention has demonstrated, and allows comparison to be made across studies (Fritz, Morris, & Richler, 2012). Table 3 presents the effect size results for the 16 of the 18 articles that used an experimental study to explore the psychophysiological benefits of nature-based interventions.

Table 3 *Experimental Studies Exploring the Psychophysiological Benefits of Nature: Measures, Results, and Effects*

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Ulrich (1981)	Participants sat in a comfortable armchair while colour images of natural environments were projected onto a wall, 2 metres from their chair. Instructions given informed them to pay attention to the screen and not to let their eyes wander. Sixty slides were projected, each for duration of 25 seconds.	Viewing colour images of urban environments.	1. Alpha amplitude 2. Heart rate 3. Self-report mood and feelings scale 4. Self-report state affect scale	Alpha amplitude was higher when participants viewed images of the natural environment in comparison to when an urban environment was viewed. No significant difference found in results that compared participants' heart rate when viewing a natural environment in comparison to viewing an urban environment. Results indicated participants were more attentive and interest levels were higher after viewing the natural environment images than the urban environment images. Results indicated an increase in sadness after participants viewed an urban environment. Results indicated an increase in self-reported fear after viewing the urban environment, and a decrease in self-reported fear after viewing a natural environment.	N/A

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Ulrich, Simons, Losito, Fiorito, Miles, and Zelson (1991)	Participants sat in a comfortable armchair while they watched colour videos on a 19" monitor. The videos portrayed environments with natural features, and went for duration of 10-minutes each.	Watching a colour videotape of an urban environment.	1. Heart rate	Results indicated a faster and more complete recovery from the stressor for participants who watched a natural environment compared to participants who viewed an urban environment.	N/A
			2. SCL	Results indicated a faster and more complete recovery from the stressor for participants who watched a natural environment compared to participants who viewed an urban environment. Graph depictions of the results illustrate that SCL had returned to baseline levels for the participants who viewed a natural environment, but not for participants who viewed an urban environment.	N/A
			3. Muscle tension	Results indicated a faster and more complete recovery from the stressor for participants who watched a natural environment compared to participants who viewed an urban environment. Graph depictions of results illustrate that muscle tension had returned to near baseline levels for participants who viewed a natural environment, whereas muscle tension show much change from the point	N/A

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
				following the stressor for those that viewed an urban environment.	

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Faber, Taylor, and Kuo (2009)	Participants walked through a designed track in a park environment with a guide. Conversations between the participant and the guide were kept to a minimum.	Walking with a guide through downtown and residential area.	4. Blood pressure	Results indicated a faster and more complete recovery from the stressor for participants who watched a natural environment compared to participants who viewed an urban environment.	N/A
			5. Self-report state affect scale	Results indicated that participants who viewed a natural environment reported lower levels of anger and fear, and more positive affect than participants who viewed an urban environment.	N/A
			1. Cognitive task to measure concentration	Concentration was better after walking through the park than walking through downtown.	$d = .52$
				Concentration was better after walking through the park than walking through the residential area.	$d = .77$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Alvarsson, Wiens, and Nilsson (2010)	Participants listened to four minutes of recorded nature sounds through a set of headphones whilst seated in a soundproof room. Noise pressure was set at 50dB.	Listening to road traffic noise at high pressure (80dB) and low pressure (50dB), and listening to ambient noises (40dB).	1. SCL	Authors concluded that SCL results showed that recovery after the stressor was faster during the nature sound condition compared to the other three noises. Skin conductance levels were significantly lower during recovery in the nature sound condition than the high noise condition only.	$d = .65$
			2. HRV	The authors reported no significant result during the different recovery conditions for HRV results.	N/A

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Roe and Aspinall (2011)	Participants spent time in an outdoor education setting (forest school). The authors did not outline any particular activities undertaken in this intervention.	Participants' regular school.	1. Self-report mood scale (energy, stress, hedonic tone, anger)	Participation in forest school was more beneficial in improving energy levels in the bad behaviour group in comparison to the good behaviour group.	$d = 1.51$
				Participation in forest school was more beneficial in reducing stress in the bad behaviour group in comparison to the good behaviour group.	$d = 1.15$
				Participation in forest school was more beneficial in improving affective states (hedonic tone) in the bad behaviour group in comparison to the good behaviour group.	$d = 1.05$
				Participation in forest school was more beneficial in reducing anger in the bad behaviour group in comparison to the good behaviour group.	$d = 1.28$
Gladwell, Brown, Tarvainen, Kuoppa, Pretty, Suddaby & Sandercock	Participants sat in a semi-supine position in a laboratory setting while 18 slides of natural scenes were	Viewing slide images of built environments.	1. HRV	PNS activity (as measured by HRV) was higher while participants viewed images of natural scenes in comparison to built environments.	$d = .23$
				PNS activity (as measured by BRS)	$d = .25$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
(2012)	projected in front of them. Participants were asked to image they were in the environment. The slideshow lasted for five minutes.		2. BRS	was higher when participants viewed nature in comparison to built environments.	
			3. Heart rate	No significant difference when viewing images of natural scenes compared to built environments.	$d = .04$
			4. Blood pressure	No significant difference in systolic blood pressure when viewing different the environments.	$d = .19$
				No significant difference in diastolic blood pressure when viewing the different environments. Authors concluded forest + sound condition produced the best effects.	$d = .08$
Annerstedt, Jönsson, Wallergård, Johansson, Karlson, Grahn, Hansen, and Währborg (2013)	Participants viewed a virtual reality natural environment with or without congruent sound, whilst seated in a comfortable chair for 40 minutes.	Sitting in a laboratory with no virtual reality nature during recovery period.	1. Heart rate	Reduction in heart rate from post stress induction tasks to 40 minute recovery period time point. (An ES was calculated using the forest sound intervention between post stress induction to 30 minutes post stress test.)	$d = 1.44$
			2. T-Wave Amplitude	T-Wave amplitude decreased for the forest + sound condition.	$d = .45$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Kelz, Evans and Roderer (2013)	The experimental school received a redesign of their schoolyard to include more greenery (shrubs and pot plants), outdoor seating, outdoor play equipment, and a drinking fountain.	Two schools in close proximity who did not receive a redesigned schoolyard.	3. HRV	PNS (as measured by HRV) increased for the forest + sound condition.	$d = .60$
			4. Cortisol	Reduction in cortisol post stress induction task and 40-minute recovery time point.	$d = .77$
			5. Self-report state and trait anxiety scale (STAI-S)	State anxiety was lower for the group in the forest + sound condition compared to the group in the forest without congruent sound.	$d = .60$
			1. Blood pressure	Diastolic blood pressure decreased in the students following the redesign of their schoolyard.	$d = .37$
				Systolic blood pressure decreased in the students following the redesign of their schoolyard.	$d = 0.14$
				Students at the school that received a redesigned schoolyard had lower diastolic blood pressure than a comparison school.	$d = .17$
				Students at the school that received a redesigned schoolyard had lower systolic blood pressure than a	$d = 0.22$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
				comparison school.	
			2. Executive Functioning Test (ANT)	Executive functioning improved for students at the school that received a schoolyard renovation.	$d = .84$
				Students at the school that received a redesigned schoolyard had better executive functioning than a comparison school.	$d = .27$
			3. Self-report wellbeing questionnaires	Self-reported wellbeing increased overall for student following the schoolyard renovation.	$d = .25$
				Self-reported wellbeing was higher overall for the students whose school received a schoolyard renovation in comparative to students at a control school.	$d = .23$
			4. Perceived Restoration Scale (PRS)	Based on the subscales of the PRS following the renovation, students at the school rated the schoolyard as more restorative in terms of:	
				1. Being away.	$d = .16$
				2. Fascination.	$d = .24$
				3. Compatibility.	$d = .48$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Kotozaki (2013)	The HT intervention for the consisted of eight weekly sessions that went for duration of 60 minutes each. The first two sessions involved interactive lectures and horticultural training, while the remaining six sessions comprised of lessons in horticulture skills such as tending to and looking after gardens. In addition, participants were also required to attend to their own gardens at home for 15 minutes a day.	Stress control education for same duration as HT intervention.	1. Self-report measure of depression in geriatric patients (GDS)	Self-reported depression had reduced following the HT intervention.	$d = .50$
				Self-reported depression had reduced two months after the HT intervention.	$d = .40$
			2. Self-report measure of positive post-traumatic growth (PTGI)	Participants had improvements in positive post-traumatic growth were reported after the HT intervention.	$d = .75$
				Further improvements in positive post-traumatic growth were reported two months after the HT intervention.	$d = 1.12$
			3. Self-report measure of physical, psychological, social, and environmental quality of life (WHO-QOL26)	Participants reported improvements in their overall quality of life following the HT intervention.	$d = .88$
				Improvements in quality of life were maintained two months after the intervention.	$d = .84$
			4. Salivary cortisol	Participants' cortisol levels had decreased following the HT intervention.	$d = .36$
			Data was collected at baseline, post intervention, and	Cortisol levels were still reduced two months after the intervention.	$d = .30$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
			at an 8-week follow-up point.		
Vella, Milligan, and Bennett (2013)	Participants took part in a 3-night outdoor recreation retreat. They were taught the technique of fly-fishing by trained professionals and over the three days, spent 16 hours fly-fishing from boats on a river. This intervention also provided the opportunity to interact with other veterans who have had similar life experiences in a natural environment setting.	None.	1. Self-report measure of PTSD symptoms (hyperarousal, re-experiencing, and avoidance)	Overall symptoms of PTSD had reduced at the post intervention follow-up.	$d = 0.68$
				Hyperarousal symptoms had reduced at the post intervention follow-up.	$d = 0.74$
			2. Self-report measure of psychological distress (anxiety, depression, and somatic symptoms of stress)	Psychological distress had reduced at the last day of the intervention.	$d = 1.39$
				Psychological distress was still reduced at the post intervention follow-up.	$d = .75$
				Somatic symptoms related to stress had reduced by the last day of the intervention.	$d = .68$
				Somatic symptoms related to stress were still reduced at the post intervention follow-up.	$d = .46$
			3. Self-report measure of mood (positive and negative effect)	Negative effect had reduced by last day of the intervention.	$d = 1.39$
				Negative effect had reduced at the	$d = .53$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
				post intervention follow-up.	
				Positive effect had increased by last day of the intervention.	$d = 1.44$
				Positive effect findings did not persist to the post intervention follow-up.	$d = .17$
			4. Self-report measure of perceived stress	Six weeks after the intervention participants rated their lives as less unpredictable, uncontrollable, and overloaded.	$d = .57$
			5. Self-report measure of perceived sleep quality.	Participants reported an improvement in sleep quality six weeks post intervention.	$d = .40$
			All self-report scales were administered two weeks prior to the intervention and at a 6-week post intervention follow-up. In addition, scales 2 and 3 were also administered on the last day of the		

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
<hr/>					
Sonntag-Ostrom, Nordin, Lundell, Dolling, Wiklund, Karlsson, Carlberg, and Järvholm (2014)	Participants were transported from their homes to a natural environment (forest) with the test leader, who avoided any therapeutic discussions. Upon arrival at the forest, participants spent 10 minutes becoming accustomed to the area. They then sat in the forest with their back against an object (tree or rock) for a period of 40minutes.	Sitting in an urban environment.	intervention.	Means and standard deviations for the three different forest conditions were averaged to compare the effects of the forest environments to the urban environment.	
			1. Measure of attention capacity	Directed attention capacity was higher after being in the forest environments compared to the urban environment.	$d = .73$
			2. Heart rate	Heart rate was lower in the forest environments than in the urban environment.	$d = .69$
			3. Blood pressure	Systolic blood pressure was not significantly lower in the forest environments.	$d = .03$
				Diastolic blood pressure was lower in the forest environments.	$d = .40$
			4. Heart rate recovery	Heart rate recovery was not significantly lower in the forest environments.	$d = .16$
Berto, Pasini,	A teacher	1. Mindfulness	1. Children's self-	The alpine walk environment was	$d = 2.23$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
and Barbiero (2015)	accompanied children into an alpine wood nearby to their school for 90 minutes. The teacher attempted to simulate the children's senses by drawing their attention to different aspects of the woods.	silence activity in the learning space. 2. Free play in their schoolyard.	report measure of perceived restorative value of environments	perceived as more restorative than the free play activity that took place in their schoolyard.	
			2. Children's self-report measure of their connectedness to nature	The alpine walk environment was perceived as more restorative than the mindfulness exercise that took place in the learning space.	$d = 1.82$
			3. Cognitive task to measure attentional performance	Performance on the cognitive task was better after the alpine in comparison to after the free play activity.	$d = 1.16$
				Completion of the cognitive task was faster after completing the alpine walk in comparison to after the free play activity.	$d = 2.52$
				Performance on the cognitive task was better after the alpine walk in comparison to after the mindfulness silence activity.	$d = 1.16$
				Completion of the cognitive task was faster after completing the alpine	$d = 1.74$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
				walk in comparison to after the mindfulness silence activity.	
			4. Heart Rate	Heart rate was lower after the alpine walk in comparison to after the free play activity	$d = 1.74$
				Heart rate was lower after completing the mindfulness silence activity in comparison to after the alpine walk.	$d = 0.12$
			5.Blood Pressure	Minimum blood pressure was lower after the alpine walk in comparison to after the free play.	$d = 0.45$
				Minimum blood pressure was lower after the mindfulness silence activity in comparison to after the alpine walk.	$d = 0.25$
				Maximum blood pressure was lower after the alpine walk in comparison to after the free play activity.	$d = 0.47$
				Maximum blood pressure was not significantly lower after the mindfulness silence activity in comparison to after the alpine walk.	$d = 0.03$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Bratman, Daily, Levy, and Gross (2015)	Participants completed a 50-minute walk along a paved path through a natural environment with dispersed shrubs and trees. Participants were advised by a research assistant at the beginning of the walk to take 10 photographs of “whatever captured their attention” along the walk.	Walking through an urban area.	1. Self-reported anxiety measure (STAI)	Anxiety was reduced from baseline to post walk for the nature condition.	$d = .46$
			2. Self-reported rumination measure (RRQ)	Decrease in rumination for nature condition.	$d = .29$
			3. Self-reported positive and negative affect measure (PANAS)	Decrease in negative effect for the nature walk condition.	$d = .68$
				Decrease in negative effect for the urban walk condition.	$d = .37$
				Decrease in positive effect for the urban walk condition.	$d = .61$
			4. Cognitive Functioning Tasks (verbal and visuospatial working memory, executive functioning)	Performance on the working memory task improved for the nature walk condition.	$d = .67$
Gidlow, Jones, Hurst, Masterson, Clark-Carter, Tarvainen,	Participants completed a 30-minute walk through natural environments that	Walking through an urban area.	1. Self-reported measure of mood (BRUMS)	Self-reported mood had improved after completing walking next to the water.	$d = .46$
				Self-reported mood was still	$d = .27$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Smith, and Nieuwenhuijsen (2016)	were either green (in a park environment) or blue (next to a canal). The accompanying research assistant provided no social interactions with the participants. Both environments had low noise levels, and visits were made on days with temperate weather conditions.		2. Measure of cognitive functioning (Backwards Digit Span)	improved 60-minutes after walking next to the water.	
				Self-reported mood had improved after completing walk in the park.	$d = .44$
				Self-reported mood was still improved 60-minutes after walking in the park.	$d = .11$
				Performance on the cognitive task improved after completing walking next to the water.	$d = .27$
			3. Self-reported measure of restorative experience	Further improvements on the cognitive task were demonstrated 60-minutes after walking next to the water.	$d = .34$
				No significant improvements on cognitive task performance were evident after walking in the park.	$d = .05$
				Performance on the cognitive task had improved 60-minutes after walking in the park.	$d = .22$
				The park walk environment was rated as more restorative than an urban	$d = 1.40$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
				environment.	
			4. Salivary Cortisol	The water walk environment was rated as more restorative than an urban environment.	$d = 1.53$
				Cortisol levels had reduced after walking in the park.	$d = .68$
				Cortisol levels had further reduced 60-minutes after walking through the park.	$d = .84$
				Cortisol levels had reduced after walking next to the water.	$d = .77$
				Cortisol levels had further reduced 60-minutes after walking next to the water.	$d = .90$
				Cortisol levels had reduced after walking through an urban environment.	$d = .68$
				Cortisol levels had further reduced 60-minutes after walking through an urban environment.	$d = .88$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
			5. HRV	The authors reported no consistent patterns in changes in HRV over time, or within each condition.	N/A
Lee, Lee, Park, and Miyazaki (2015)	In greenhouse room, participants were required to tend to and transplant <i>Peperomia dahlstedti</i> , a common indoor plant.	Completing a computer word processing task.	1. HRV	SNS activity (as measured by HRV) was significantly lower during the plant transporting task in comparison to the computer task.	$d = .66$
				PNS activity (as measured by HRV) was significantly higher during the plant transporting task in comparison to the computer task.	$d = .83$
			2. Blood pressure	Participants' diastolic blood pressure was significantly lower after the plant transporting task in comparison to after the computer task.	$d = 1.15$
			3. Self-report measure of comfort, relaxation, and naturalness	Participants reported feeling comfortable, soothed, and natural after completing the plant activity. After completing the computer task they reported feeling uncomfortable, awakened, and artificial.	N/A
Song, Ikei, Kobayashi, Miura, Taue, Kagawa, Li,	An experimenter from the study guided participants through a	Walking through an urban environment.	1. HRV	PNS activity (as measured by HRV) was significantly higher when walking through forest environment.	$d = 2.0$

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Kumeda, Imai, and Miyazaki (2015)	predetermined course. The course took 17 minutes to complete, and led them through a flat forest environment.		2. Heart rate	Heart rate was significantly lower while walking through the forest environment.	$d = .78$
Swank, Shin, Cabrita, Cheung, and Rivers (2015)	Participation in a NBCCPT twice weekly for seven weeks. Each session went for a duration of 30 minutes. NBCCPT aligned with regular CCPT guidelines with modifications to include a natural environment where natural materials were used instead of toys.	Baseline measures.	1. Observable on-task behaviours	<p>NBCCPT was effective in improving observable on-task behaviours for participant one.</p> <p>NBCCPT was ineffective in improving observable on-task behaviours for participant two.</p> <p>NBCCPT was ineffective in improving observable on-task behaviours for participant three.</p> <p>NBCCPT was ineffective in improving observable on-task behaviours for participant four.</p>	<p>PEM=.86</p> <p>PEM=.14</p> <p>PEM=.29</p> <p>PEM=.14</p>
			2. Observable problem behaviours	NBCCPT was effective in reducing problem behaviours for participant one.	PEM=.71

Citation	Intervention	Control/Comparison	Measures	Results	Effect size
Largo-Wight, O'Hara, and Chen (2016)	Participants sat at a desk facing a plain white wall whilst they listened to the nature sound of ocean waves for 15 minutes.	1. Listening to classical music. 2. Silence.		NBCCPT was effective in reducing problem behaviours for participant two.	PEM=.86
				NBCCPT was ineffective in reducing problem behaviours for participant three.	PEM=.14
				NBCCPT was ineffective in reducing problem behaviours for participant four.	PEM=.14
			1. Muscle tension	Pre-post reduction in muscle tension for the participants who listened to the nature sounds.	$d = .65$
			2. Heart rate	Pre-post reduction in pulse rate for the participants who listened to the nature sounds.	$d = .40$
			3. Self-reported stress	Pre-post reduction in self-reported stress for the participants who listened to the nature sounds.	$d = .65$

Note. Results with N/A denote that information in the results section did not permit the calculation of effect size; SNS = sympathetic nervous system; PNS = parasympathetic nervous system; SCL = skin conductance level; HRV= heart rate variation; HF-HRV= high frequency heart rate; BRS= baroreceptor sensitivity.

Faber, Taylor, and Kuo (2009), Gladwell et al. (2012), and Bratman et al. (2015) reported Cohen's d effect sizes in the results section of their studies. For comparative purposes, effect sizes were calculated where the results in the articles permitted this to take place. These calculations were completed for Alvarsson et al. (2010), Roe and Aspinall (2011), Annerstedt et al. (2013), Kotozaki (2013), Vella et al. (2013), Sonntag-Ostrom et al. (2014), Berto et al. (2015), Gidlow et al. (2016), Lee et al. (2015), Song et al. (2015) and Largo-Wight et al. (2016), using an online calculator (Wilson, n.d.). Effect sizes results for Kelz et al. (2013) are a combination of effect size results reported in the article and through use of the online calculator. The single-case study by Swank et al. (2015) reported their effect size as a Percentage of Data Points Exceeding the Median (PEM). Effect sizes can be interpreted according to Cohen's (1992) guidelines where effect sizes of .20 are small, .50 are medium, and .80 are large. For PEM statistics, .90 and higher is regarded as very effective, .70 to .89 as effective, .50 to .69 of debatable effectiveness, and lower than .50 is considered ineffective (Scruggs & Mastropieri, 2001).

Autonomic nervous system.

Sympathetic nervous system. Figure 1 illustrates the reported and calculated effect sizes across studies that used a measure of SNS activity. Six studies used a measure of heart rate to explore the effect of nature-based interventions on SNS activity (Gladwell et al., 2012; Annerstedt et al., 2013; Song et al., 2015; Sonntag-Ostrom et al., 2014; Largo-Wight et al., 2016; Berto et al., 2015). The effect size results across the studies ranged between small ($d=.04$) and large ($d=1.74$) effects for participants' heart rates reduction following a nature-based intervention. For diastolic and systolic blood pressure, effect size results across four studies (Berto et al., 2015; Sonntag-Ostrom et al., 2014; Kelz et al., 2013; Gladwell et al., 2012) ranged from $d=.08$ $d=.47$, indicating small effects in the reduction in blood pressure following a nature-based intervention. Other physiological measures of SNS response to

nature-based interventions were limited to only one study that used this type of measurement; this included muscle tension (Largo-Wight et al., 2016), T-wave amplitude (Annerstedt et al., 2013), SCL (Alvarsson et al., 2010), and SNS component of HRV (Lee et al., 2015). Overall, there was a wide range of effects ranged from small to large, with the largest effect demonstrated by the measure of heart rate activity.

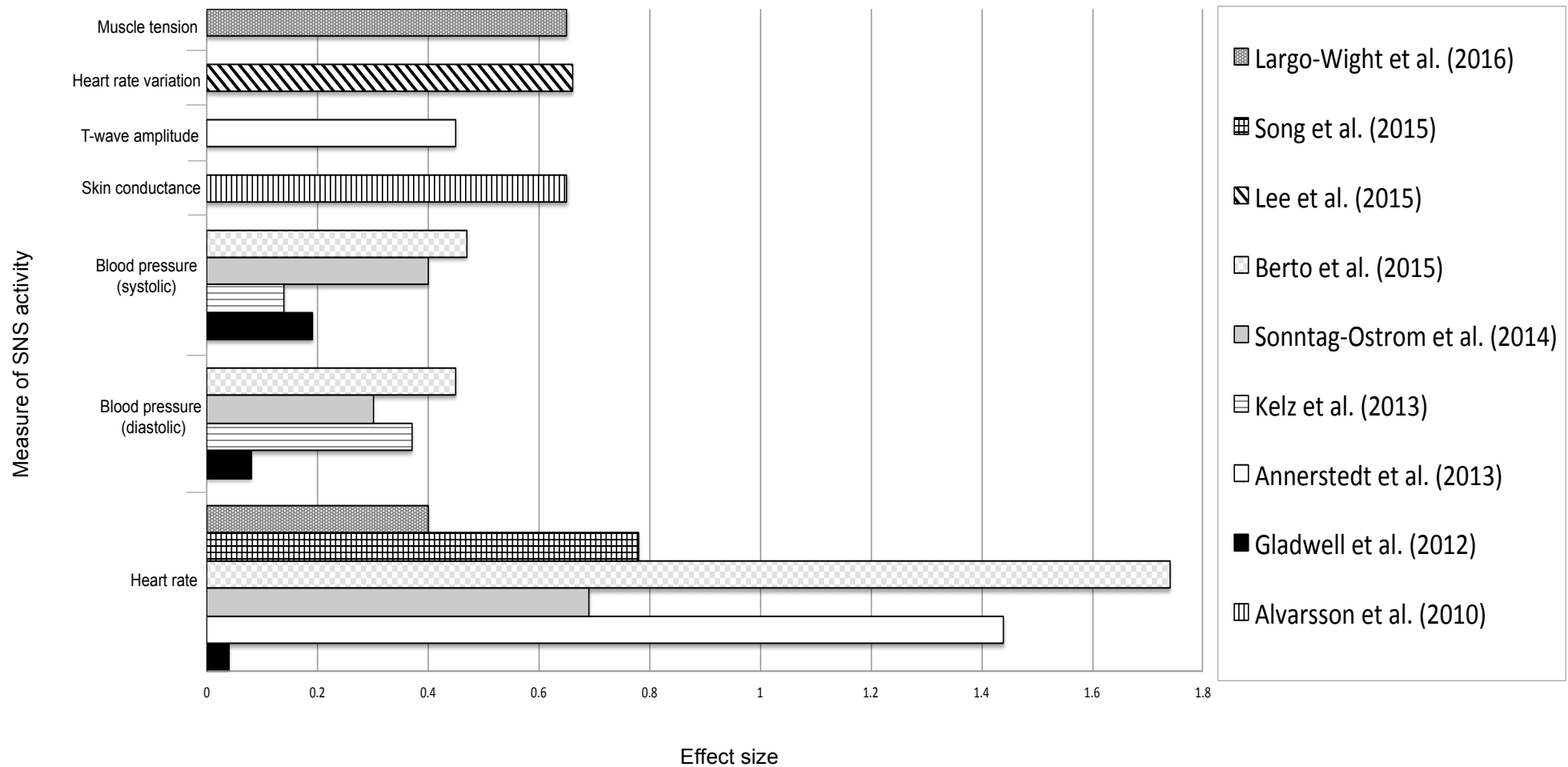


Figure 1: Effect size results across studies that used a measure of sympathetic nervous system activity to explore the effects of a nature-based intervention.

Parasympathetic nervous system. Four studies (Song et al., 2015; Lee et al., 2015; Annerstedt et al., 2013; Gladwell et al., 2012) used high-frequency HRV as a measure of PNS activity. Effect size results ranged between $d=.23$ and $d=2.0$ indicating a small to large effect in the increase of PNS activity.

Cortisol/HPA activity. Three studies measured participants' salivary cortisol as a measure of HPA axis activity (Gidlow et al., 2016; Annerstedt et al., 2013; Kotozaki 2013). All these studies demonstrated a decrease in cortisol with effect size results that ranged from $d=.30$ to $d=.90$. Overall, these effects ranged from small to large on reducing participants' cortisol levels.

Cognitive performance. Six studies measured the cognitive performance of participants following a nature-based intervention. Cognitive performance was measured by either an attention capacity task (Faber Taylor, & Kuo, 2009; Kelz et al., 2013; Sonntag-Ostrom et al., 2014; Berto et al., 2015) or a working memory task (Bratman et al., 2015; Gidlow et al., 2016). Across the four studies that measured attention capacity and performance, effect size results indicated an improvement ranging from $d=.52$ to $d=2.52$ following a nature-based intervention. The two studies that measured working memory showed an improvement following a nature-based intervention with effect sizes ranging from $d=.05$ to $d=.67$. Overall, effects ranged from medium to large for improving attention capacity, and small to medium for improving working memory.

Self-report measures of stress. There was a wide range of self-report measures used across the 13 studies that explored the psychophysiological effects of a nature-based intervention; however, due to the focus of this research being on the stress reducing effects of nature, only a summary of self-reported measures of stress is provided below. Effect size calculations of all self-reports measures used across the studies can be found in Table 3.

Three studies used a measure of self-reported stress (Largo-Wight et al., 2016; Vella et al., 2013; Roe & Aspinall, 2011) to explore the effectiveness of nature-based interventions on psychophysiological stress. Results indicated a reduction in self-reported stress with effect sizes ranging between between $d=.40$ (Vella et al., 2013) and $d=.65$ (Largo-Wight et al., 2016). Results from Roe and Aspinall (2011) indicated that a nature-based intervention was more effective in reducing self-reported stress in participants with problem behaviours than those without problem behaviours ($d=1.15$). Overall, effects ranged from small to large for improving participants' self-reported stress.

Analysis and Consideration of Methodology Across Studies

Participant characteristics and sampling. Analysis of participants recruited across the 18 studies that explored the psychophysiological response to nature-based interventions highlights a number of considerations that need to be addressed. Firstly, as summarised above, 13 of the studies included adult participants, leaving only five studies in which the effectiveness of using nature-based interventions for reducing stress in children can be explored. This ratio of adult to child studies requires a considerable reliance on adult studies to understand the potential efficacy of these interventions. As such, some reservations may be made about the generalisation of these findings from adult studies to a child population. For example, it could be argued that children's physiological reactions to stress are different from those of adults who are more physiologically developed; however, research by Kudielka, Buske-Kirschbaum, Hellhammer, and Kirschbaum (2004) found no age difference in physiological responses to stress indicated by cortisol release during a stress inducing task. Furthermore, two of the child participant studies included in the review that used a physiological measure of stress showed similar patterns of results to those in adult studies, following a nature-based intervention (see Kelz et al., 2013; Berto et al., 2015). Nonetheless, further research is needed to uphold the efficacy of using nature-based interventions for a child population in this currently underexplored research area.

Healthy participants with no preexisting physiological or psychological disorders were also overrepresented in 11 of the 18 studies that reviewed the stress reducing effects of nature-based interventions. In three of the 11 studies that had healthy subjects, participants were required to undergo a stressful task or activity to investigate the stress reducing effects of nature-based interventions (Ulrich et al., 1991; Alvarsson et al., 2010; Annerstedt et al., 2013). It could be argued, however, that induced stress would subside over time anyway, and

generalisability of the results could not be made to chronic conditions such as post-traumatic stress.

The remaining seven studies, in which participants had a preexisting diagnosis or disorder, provide more relevant results for the use of nature-based intervention for individuals with post-traumatic stress. Included in these seven studies were adult participants who had hypertension, exhaustion disorder, PTSD, as well as child participants who had ADHD and problem behaviours. Hypertension is a stress related condition that has been shown to increase SNS hyperactivity (Sparrenberger, 2009) and is prevalent among individuals with post-traumatic stress symptoms (Balient et al., 2015). Likewise, the aetiology of exhaustion disorder is commonly attributed to individuals being exposed to chronic stress (Hasselberg, Jonsdottir, Ellbin, & Skagert, 2014). In contrast, children may express stress differently from adults because of their limited cognitive appraisal of traumatic events. As outlined in Chapter 1, post-traumatic stress in children may manifest with more behavioural symptoms such as deficits in concentration, restlessness, or anger. These symptoms share similarities with those of ADHD, which have been related to impaired activity in the PFC of individuals with either of these disorders (Friedman & Rapport, 2015). As the comorbidity between these two disorders becomes more recognised in research (Biederman et al., 2013), it may be worthwhile to explore the effectiveness of ADHD interventions for children with post-traumatic stress symptoms. At present there are no studies that have explored the effectiveness of nature-based interventions in a population of children with a specific stress related disorder. This highlights the need for such a study.

An additional methodological issue concerns the recruitment of participants to take part in these studies. At least eight of the studies reviewed used volunteers as participants, and therefore may be subject to self-selection bias. In particular, researchers whose intervention involved direct contact with nature may have found it difficult to blind the

purpose of these studies. This may have led to an overrepresentation of participants with a preference for nature and who may spend more time outdoors being physically active. The seemingly objective physiological measures may therefore be biased towards healthy individuals, and self-report measures favour the salutogenic effects of being in nature. Conversely it is also important to consider that some individuals may not enjoy nature or spending time outdoors. Milligan and Bingley (2007) argue that researchers must not assume that all individuals find natural areas, such as woodlands and forest, therapeutic and restorative. Their study found that while some young adolescents described positive relationships with natural environments, others described these experiences as dangerous, intimidating, and scary (Milligan & Bingley, 2007). The authors described the role of the media and parents, who expressed fears around natural areas being dangerous and unsafe when children are young, may shape an individual's negative perspective in later life. Understanding an individual's preference for nature is therefore an important aspect to consider when implementing a nature-based intervention. Gathering information about the participant's experience of a nature-based intervention may allow researcher to discuss the apparent effectiveness or ineffectiveness of the intervention.

Study design. All 18 of the studies that explored the effectiveness of nature-based interventions used an experimental or quasi-experimental design. All but one of these studies (Vella et al., 2013) used a control group or condition to increase the amount of causation that can be attributed to the results attained from a nature-based intervention; however, in seven of these studies the control condition required participants to walk, sit, listen, or look at an urban environment, which highlights an area of contention. Firstly, if a significant difference is found between results from an urban and a natural environment condition, it could be argued that the difference is due to the stress-inducing factors of the urban environment rather than the benefits of the natural environment (Bowler et al., 2010). Because of this,

control conditions should aim to match the arousal level of the experimental condition as closely as possible. Furthermore, a control or comparison condition of an urban environment may not be reflective of the environments in which individuals spend considerable amounts of time. These control conditions required participants to sit next to busy intersections (Sonntag-Ostrom, 2014) or listen to high traffic noise (Alvarsson et al., 2010) and, for example, it could be argued is not analogous to the environmental conditions that individuals, especially children, frequently interact with. To address this, control or comparison conditions should be reflective of similar environments or activities that the participants frequently encounter.

Across the nature-based intervention literature is a preference for using group designs, which is apparent in that 17 of the 18 studies reviewed used this design for their research. Blampied (2001) argues that this although scientific research frequently uses this approach to research design, beneficial individual data is overlooked when group averages are obtained. Furthermore, group designs require large number of participants in order to reduce the likelihood of Type II error (not obtaining a statistically significant result when there is an effect from the intervention). A possible solution for these issues is using a single-case design, as used in one of the reviewed studies (Swank et al., 2015). Single-case studies allow the researcher to evaluate the effectiveness of the intervention by allowing each participant to act as their own control through the use of baseline comparison data (Blampied, 2001). Furthermore, the intervention phase in single-case designs occurs over a number of days, allowing for the results to demonstrate any effects that repeated use of the intervention may have.

Measures. Different measurements and techniques were used to collect data across the studies that explored the psychophysiological effects of nature-based interventions. In addition, there was variation amongst the studies as to when the measurements were taken.

Consideration of these measures and the different time points of data collection are discussed below.

Firstly, the most common measure, used across the studies, was a self-report measure, which was used in 14 of the studies. Self-report measures can be open to biased reporting from participants, especially if they are aware of the study's objective and so responses may reflect their assumptions that nature should be beneficial. As mentioned earlier the blinding of participants to the research objectives may be difficult, especially in within-participant studies, because participants may guess the hypothesis of the study based on the different activities within the conditions. This limitation means that any data collected from self-report measures are subject to issues regarding validity of the construct they are said to measure. Furthermore, young children's limited understanding of their emotions may make it difficult for them to self-report these measures with any degree of accuracy. Parent report measures and behavioural observations may provide more accurate information that will help address this issue.

Physiological measures are an objective form of assessing the stress reducing effects of a nature-based intervention. There are, however, a number of considerations that need to be addressed regarding their use. Firstly, physiological measures, such as heart rate, blood pressure, and skin conductance are influenced by a number of factors, including physical activity, eating, medication, and individual physiology. Some interventions reviewed involved a degree of physical activity such as walking through a natural environment, which may have increased participants' heart rate and blood pressure. This could possibly lead to inaccurate results, because the heart rate may not be a valid measure of participants' stress. In their study, Berto et al. (2015) identified this potential limitation and addressed it by allowing 10 minutes post activity rest prior to taking measures of heart rate and blood pressure. Nevertheless, variability amongst individual's physiology may affect studies that

employ a group design because individuals whose data is outside the average range may influence results either positively or negatively. Single-subject designs may provide a better design to use because they allow the participant to act as their own control.

Measures were used across the studies at different points to gather data. All but four studies (Largo-Wight, 2016; Kelz et al., 2013; Kotozaki, 2013; Berto et al., 2015) gathered data from physiological stress measures continuously throughout the interventions. The four studies that did not use continuous physiological measures used pre-post measures, apart from Berto et al. (2015) that gathered post-intervention data only. All studies used pre-post intervention self-report measures and measures of cognitive functioning. Although pre-post intervention measures are effective, in that baseline comparisons can be made, it is also important to consider the effects that take place during the intervention that may not be detected by pre-post measures. Although this may not be achievable for self-report or cognitive measures, available technologies allow researchers to gather physiological data continuously through an intervention by the use of devices such as heart rate monitors worn by the participants. Another limitation identified through analysis of the literature is that follow-up data collection was only conducted in two of the studies (Vella et al., 2013; Kotozaki, 2013) while the other studies gathered data within hours following the intervention only. Although it could be hypothesised that repeated short-term exposure to nature-based interventions may result in cumulative benefits for individuals, further research is needed to explore the psychophysiological benefits of nature-based interventions over a long-term period.

Analysis and Consideration of Interventions Across Studies

Nature can be used in a therapeutic manner in a range of different ways. This is illustrated by the variation of nature interventions across the studies and the manner in which nature has been incorporated. Although many researchers related the beneficial outcomes of

the intervention being due to interaction with nature, it is also important to consider other features of the intervention that may have influenced the results. In three studies (Swank et al., 2015; Kotozaki, 2013; Vella et al., 2013) nature was integrated into more comprehensive intervention that involved other therapeutic elements. For example, both the horticultural therapy used in Kotozaki, 2013, and the outdoor recreation experience, in the study by Vella et al. (2013), involved social interaction with other individuals within the therapy group. Vella et al. (2013) noted that social support and interaction with individuals who have similar trauma experiences was an inextricable component for the participants in their study. Even in the studies that involved walking through a natural environment, a researcher or guide may have interacted socially with the accompanied participants. Nonetheless, it is difficult to disentangle the elements of the nature-based intervention that are working for the participants. Similarly in the study by Swank et al. (2015) it can be argued that positive behavioural changes seen may be a result of the CCPT technique used by the therapist, rather than the natural environment in which it took place. Comparative studies between regular CCPT and NBCCPT would help justify the benefits of a natural environment.

Moreover, even in five studies that involved walking through a natural environment, apart from Song et al. (2015), who reported that the person accompanying the participant remained a short distance behind them, researchers made no explicit mention in their procedures that conversations between the researcher and participants were avoided. Bowler et al. (2010) argued that the social interaction alone might be responsible for the beneficial outcomes of exercising in natural environments. Furthermore, exercise alone was beneficial in reducing participants' cortisol and improving mood in the study by Gidlow et al. (2016) as both natural and urban environments demonstrated improvements from baseline measures taken prior to walking in these environments. It is difficult, therefore, to draw valid

conclusions about the therapeutic benefits of nature, because it is not always possible to identify the mechanisms through which the intervention is working for the individual.

In contrast, interventions that involve simulated nature experiences may be more controlled by the researcher. As opposed to direct nature exposure, interventions that involve participants to engage in a simulated nature experience can more easily be completed without supervision, which limits the possibility that interaction with others is the beneficial mechanism of the intervention. For children especially, safety and ethical reasons may limit interventions that involve direct contact with nature. Comparative to direct nature interventions, simulated nature interventions also limit other confounding environmental stressors such as temperature, weather, pollution, and noise annoyance, which can affect an individual's physiological stress (Markevych et al., 2014). It also controls for the possibility that exercise alone is the stress reducing mechanism, which has been demonstrated to be an effective stress reducing intervention for children with PTSD (Motta, McWilliams, Schwartz, & Cavera, 2012). However, counterarguments to this could suggest that simulated nature interventions may be stress reducing because the participant is usually sedentary, and seated in a comfortable chair for the duration of the intervention. To overcome this, studies that use a simulated nature experience should include a comparison activity, either during baseline or as a control group, where participants are exposed to an exact replication of the nature-based intervention but the theme of the videos, images, or a virtual reality experience *are non-nature*. It is important to note that the non-nature content of the comparison activity should not be stress-inducing nor arousing because this may lead to invalid conclusions when comparisons are made between the results of the two activities. Use of the comparison activity would therefore allow more confident conclusions to be drawn that any resulting psychophysiological benefits are alone due to the nature element alone.

Analysis and Consideration of the Effectiveness Across Studies

As detailed in the summary above, there was a wide variation amongst the studies regarding effect sizes calculated for exploring the psychophysiological benefits of nature-based intervention. These results need to be considered against a number of variables including comparison conditions in which effect sizes may have been calculated against, characteristics of the participant, and the intervention duration. This will ensure a more informed and rationalised decision can be made for the current study.

Across the studies, effect sizes were calculated by either comparing baseline and post intervention data, or data from the nature-based condition to a comparison condition. Concerns regarding the use of a comparison condition are outlined above in the Study design section of the analysis that acknowledges that activities in these comparison conditions may increase participants' levels of arousal. Because of this, it is important to consider that significant effect size results between a nature-based and comparison condition may be due to the increased arousal produced by the comparison condition, rather than the stress reducing effects of the nature-based condition. For example, the largest effect sizes reported for heart rate, blood pressure, and attention restoration came from the study by Berto et al. (2015) where the comparison condition was a free play activity where children played outside. Although the researchers delayed taking the measures until 10 minutes after the activities it is important to consider that children may have been more physically active during this time, which would increase the participants' arousal. Because of this, the large effect size calculated may be more reflective of increased activity in the free play condition, rather than the stress reducing effects of the nature-based activity. Similar arguments can also be made for the largest effect size calculated for PNS activity in the study by Song et al. (2015). Researchers in this study used an urban walk as a comparison condition to a nature walk. Comparative effect size results illustrated an increase in PNS activity in the nature walk

condition compared to the urban walk condition however, it needs to be considered that decreased PNS activity in the urban walk was more responsible for the large effect size produced. This consideration highlights the need for baseline measures to overcome the issues created when comparison conditions are used.

Another important consideration when interpreting the results is the different durations of the nature-based interventions across the studies. As summarised earlier, interventions ranged from watching a brief slideshow for five minutes (Gladwell et al., 2012) to an eight-week horticultural therapy intervention (Kotozaki 2013). Duration of the intervention does not appear to be an influencing factor for heart rate and cognitive task performance results for children in that both a seven-week intervention (Kelz et al., 2013) and a brief 90-minute intervention (Berto et al., 2015) produced significant effect size improvements in these two measures. Changes in cortisol levels as a results of nature-based interventions appear to be more influenced by intervention duration however, as effect sizes from a brief intervention (Gidlow et al., 2016) produced significantly larger effect sizes than those from an eight-week intervention (Kotozaki, 2013). It should be noted that there is contention surrounding the use of cortisol as an accurate biomarker of stress (Hellhammer, Wust, & Kudielka, 2009), and that cortisol levels are not homogenously high or low in individuals with post-traumatic stress (Meewisse et al., 2007; Klaassen et al., 2012). Nonetheless, future studies could have participants experiencing the intervention for a brief duration across a number of daily sessions. This would help determine any immediate, as well as long-term, benefits of the intervention.

A final important consideration identified when analysing the effectiveness of nature-based intervention across the studies was that larger effects size results came from studies where participants had a preexisting stress related disorder, or had completed a stress inducing task prior to the nature-based activity. Other than the study by Berto et al. (2015)

which limitations surrounding interpretations of results have been outlined above, effect size results for heart rate measures were largest in studies involving participants that had hypertension (Song et al., 2015), exhaustion disorder (Sonntag-Ostrom et al., 2014), or underwent an induced stressor prior to the intervention (Annerstedt et al., 2013). In comparison, lower effect sizes for heart rate results were evident in the other two studies involving unstressed participants (Gladwell et al., 2012; Largo-Wight et al., 2016). Similar patterns of findings were demonstrated in PNS activity results where the largest effect size came from the study involving participants with hypertension (Song et al., 2015). Furthermore, effect size results from Roe and Aspinall (2011) highlighted that nature-based activities were more beneficial in improving mood for participants' good behaviour, even when baseline measures were similar across the groups. Because of this, it can be hypothesised that nature-based interventions have more of an effect on participants with preexisting stress related symptoms.

Rationale for the Current Study

Post-traumatic stress symptoms are a common mental health consequence following exposure to natural disasters. Current evidence based and recommended treatments for post-traumatic symptoms arguably do not approach the underlying neurological disruptions caused by trauma exposure. With the emergence of alternative treatments, the use of nature-based interventions may be a potential avenue to explore. There are a number of studies that have upheld the stress reducing benefit of both real and simulated nature experiences. Simulated nature interventions are arguably an easy, cost effective way to potentially reduce physiological and behavioural symptoms of stress in young children. They do not require to presence of a trained professional to administer, could be used in a school environment where post-traumatic stress behaviours may be evident. To date, there are no studies that have

explored the effects of a simulated nature experience on children, or individuals with stress related symptoms or disorders.

Based on this rationale, the following research question was proposed: is a simulated nature experience effective in reducing the physiological and behavioural responses of post-traumatic stress in children exposed to the Christchurch earthquakes?

Chapter Three

Methods

Study Design

This study used a single-case research design replicated over four participants to explore the research question. Single-case designs allow researchers to evaluate the effectiveness of the intervention against each participant's individual baseline comparison data (Blampied, 2001). A repeated measures procedure was used with the dependent measures of heart rate and teacher-reported behaviour taken for each participant over a period of 20 consecutive school days. The repeated measure procedure helped establish the predicted path of the baseline data into the succeeding intervention phase, allowing the researcher to detect any difference between the actual data path and the path predicted from baseline (Carr, 2005).

There were four different phases during this study: Baseline 1, Baseline 2, nature-video intervention, and return to Baseline 1 conditions. The four days of Baseline 1 provided data regarding the participants' physiological and behavioural stress related symptoms as they engaged in their regular school activities. Baseline 2 served as a comparison phase where participants watched a non-nature video for comparison to the intervention phase, where participants watched a nature video. This phase was included so that any results that indicated a reduction in stress during the nature-video intervention phase were due to the nature content of the video, and not confounded by other variables, such as sitting and watching a video, which may also be stress reducing. Return to Baseline 1 conditions phase provided data about any changes in the dependent measures that occurred after the intervention was withdrawn.

Human Ethics Approval

An application was made to the University of Canterbury Educational Research Human Ethics Committee (UCERHEC). Approval for the current study was granted on by the UCERHEC on September 14th 2016 (Ref: 2016/47/ERHEC). A copy of the letter can be found in Appendix A. Information sheets and assent/consent for the Principal, teachers, Board of Trustees, parents, and children provided during the study can be found in Appendices B – I.

Recruitment and Informed Ethical Process for School and Teachers

Following UCERHEC approval, the researcher met with the Principal of a school and provided a copy of the information sheet. The researcher provided the Principal with the opportunity to answer any questions regarding the study. The Principal provided written consent for the study to take part at the school, and obtained written consent from the Board of Trustees. The Chairperson of the Board of Trustees signed the consent form on behalf of the board. The Principal gave the researcher permission to approach teachers to give an overview of the study, and invite them to take part. Written informed consent was obtained from all teachers who chose to participate in two different learning spaces, following a discussion with the researcher about project and the role of the teachers in the study. These two learning spaces will be referred to as Learning Space A and Learning Space B.

School Setting

School description. The study took place at a decile three primary school located in south-east Christchurch, New Zealand. The current school role at the time of the study was 386. Christchurch Earthquake Recovery Authority (CERA) reported in 2014 that the area of south-east Christchurch received significant damage and disruption as a result of the earthquakes in the region. This area was in the same location as the study by Liberty et al. (2016) that found an increase in problem behaviours following the Christchurch earthquakes.

Learning environment descriptions. Learning Space A and Learning Space B both used a collaborative teaching approach. There were five registered teachers and approximately 115 students in Learning Space A, and five registered teachers and approximately 121 students in Learning Space B at the time of the study. Both learning spaces had children aged seven to 11 years of age. Within each learning space were five individual home bases. Each home base had one teacher that was responsible for a group of approximately 20-25 students within their respective learning space. Students would spend time in their home bases at different points of the day for administration activities such as attendance and notices. All learning activities throughout the day took place in smaller groups, and were led by one of the five registered teachers in the learning space.

Both Learning Space A and Learning Space B were newly built, modern learning environments. Modern learning environments utilise flexible, open space areas that cater for larger learning groups over single cell learning spaces (Ministry of Education, 2017). Breakout rooms are spaces that are separated from the main learning environment with glazing or glass doors. Learning Space A and Learning Space B both had a large open plan area room and three separate breakout rooms.

Screening Measures

Demographic questionnaire. The researcher developed a short questionnaire to obtain demographic information from participants such as name, age, gender, and ethnicity. This provided information to be used in the participants' descriptions, and also ensure that the child met the age criterion set for the study (outlined below). A copy of the questionnaire can be found in Appendix J.

Health and behaviour questionnaire (HBQ). The health and behaviour questionnaire (HBQ) was created for the current study by the researcher to provide information about the participants' somatic and behavioural post-traumatic stress symptoms

(Appendix K). The HBQ was a parent report questionnaire which provided information that ensured suitable participants were recruited for the study. The decision was made to develop a questionnaire because most studies evaluating post-traumatic stress symptoms in children generally used questionnaires that explored children's reactions to traumatic events that they could consciously recall (Hawkins & Radcliffe, 2005). Such questionnaires had insufficient items that related to physiological and behavioural symptoms of post-traumatic stress, which was the specific focus of this study.

The HBQ contained a total of 20 items. Eight items related to somatic symptoms of stress that reflect symptoms related to hyperarousal outlined in Chapter 1 (see Table 1), such as troubles with sleep, stomachaches, and headaches. These items were taken from the parent report questionnaire used in the study by Liberty et al. (2016). The remaining 12 items were items related to behavioural symptoms of post-traumatic stress and were taken from Dehon and Scheeringa's (2005) modified post-traumatic stress scale for children. Parents were asked to respond by circling either *yes* or *no* as to whether the items applied to their child. The questionnaire gathered information about whether post-traumatic stress symptoms have been present over the past 12 months, as well as over the past week. This ensured that the participants were experiencing chronic as opposed to acute stress symptoms. It also ensured that these issues were a current concern.

Christchurch Earthquake Questionnaire. The Christchurch Earthquake Questionnaire gathered information about the child's location during five of the major earthquakes that occurred in the Canterbury region (see Appendix L). Parents were asked to respond by circling *yes* or *no*. This information was used to ensure participants met a criterion set for the study (outlined below).

Participant Recruitment

The sample size of four children was selected for this study because that matched the participant number in the only single-case study reviewed (Swank et al., 2015), and a larger participant group was not needed in single-case designs to acquire significant results (Blampied, 2014). Participants were to meet the following criteria in order to take part in the study:

1. The child was living in Christchurch or the Canterbury region at the time of the two major earthquakes (September 4th 2010 and February 22nd 2011).
2. The child was 7 or 8 years of age. This age was selected because the participants would have been 12 – 24 months of age at the time of the Christchurch earthquakes. This age represents a developmentally sensitive period where symptoms of post-traumatic stress may be influenced by the timing of the earthquakes (Liberty et al., 2015).
3. The child had somatic and behavioural stress related symptoms as reported by parents/caregivers on the HBQ. These symptoms needed to have been present over the past year, and also be a current issue.
4. The child's home base teacher reports current stress related behaviours, similar to those reported by the parent, in the school environment. Swank et al. (2015) used a similar recruitment approach; however, teacher nomination of suitable participants occurred prior to gaining parental consent.

Recruitment process. The researcher met with all children in Learning Space A, who were seven or eight years old, and gave a brief outline of what the study involved. All children who were interested in participating were provided with an envelope that contained the following: a copy of the child and parent information sheet; parent consent form; child assent form; and a booklet that contained the three screening measures outlined above. The

information sheets indicated that only four participants would take part in the study. Those wishing to participate were asked to return completed forms and questionnaires by a due date. By the due date given, seven children and their parents had indicated that they wished to take part, but only two of these seven children had stress related behaviours that were confirmed to be similar in the school environment by their home base teacher. Because of this, participation was opened up to children in Learning Space B where a further two participants were recruited.

Participants

The following four participants were recruited because they met the criteria set for the study. Below is a brief description of the child participant using information provided by the screening measures completed by the child's parent/caregiver. Pseudonyms have been used to ensure confidentiality.

Sarah. Sarah was an 8-year-old girl who identified as New Zealand European. She was a student in Learning Space A. Over the past 12 months Sarah had experienced trouble getting to sleep, nighttime waking, and a fear of sleeping alone. Sarah had also experienced headaches and stomachaches, and changes in her eating habits. She reportedly exhibited a number of behavioural stress related symptoms including: anger outbursts, difficulty concentrating, restlessness, tenseness or nervousness, a strong temper, clinginess to adults, and demanding a lot of attention.

Reece. Reece was an 8-year-old boy who identified as European Maori. He was also a student in Learning Space A. Reece had experienced somatic symptoms such trouble going to sleep, eating problems, headaches, and stomachaches. According to his parent, he also exhibited a number of behavioural stress related symptoms including: anger outbursts, difficulty concentrating, restlessness, a strong temper, clinginess to adults, and demanding a lot of attention.

Anna. Anna was a 7-year-old girl who identified as New Zealand European. She was student in Learning Space B. Anna had experienced problems with sleep including troubles going to sleep and a fear of sleeping alone. Anna had also experienced headaches and stomachaches. There were a wide range of behavioural stress related symptoms that Anna reportedly displayed such as: anger outbursts, difficulty concentrating, tenseness or nervousness, a strong temper, acts impulsively, clinginess to adults, and demanding a lot of attention.

Jake. Jake was a 7-year-old boy who identified as New Zealand European. He was also a member of Learning Space B. Over the past 12 months Jake had experienced trouble getting to sleep at night, nighttime waking, and a fear of sleeping alone. Jake had also experienced stomachaches, and would wet or soil the bed. Jake reportedly displayed a wide range of behavioural stress related symptoms including: anger outbursts, difficulty concentrating, restlessness, tenseness or nervousness, a strong temper, acting impulsively, clinginess to adults, and demanding a lot of attention.

Dependent Measures

Teacher-reported behaviour rating scale (TBRS). A scale was developed for the current study to measure participants' stress related behaviours (Figure 2). The decision was made to create a TBRS because the researcher was unable to observe more than one child at the appropriate time. A teacher rating scale that was suitable to the behaviours in the current study had not been used in previous studies. Only one study in the review had used an observation scale to measure the participant's behaviour (Swank et al., 2015). In this study, the Direct Observation Form (DOF) (McConaughy & Achenbach, 2009) was completed by an independent observer but the DOF requires the rater to score a total of 88 items, which is time consuming if it were to be used as a repeated measures instrument. Because of this, 10 items were taken from the DOF to create the TBRS. The items selected reflect behavioural

symptoms of post-traumatic stress outlined by Dehon and Scheeringa (2005) and were similar to those used in the study by Liberty et al. (2016) to explore post-traumatic stress symptoms in children following the Christchurch earthquakes.

The TBRS had 10 items that required the participants' home base teacher to rate the occurrence, duration, and intensity of observed itemised behaviours over a 30-minute duration. Items are rated on a 0-1-2-3 scale where 0= *never*, 1= *maybe/slightly*, 2= *definite, but mild*, and 3= *definite and strong occurrence*. Adding the numerical rating for each item gave an overall TBRS score. Items on the TBRS can be separated by internalising and externalising behaviours of post-traumatic stress symptoms (Dehon & Scheeringa, 2005). Items A, B, G, and H, reflect externalising behaviours and B, D, E, F, I, and J, reflect internalising behaviours.

Teacher-reported behaviour rating scale (TBRS)				
Child's Name: _____		DATE: _____		
Teacher's Name: _____				
Observation Time: Start _____ Stop: _____				
Over the past 30 minutes, how often did you observe that the child:				
	Never	Maybe/slightly	Definite, but mild	Definite and strong occurrence
a. Argued	0	1	2	3
b. Didn't concentrate or pay attention for too long	0	1	2	3
c. Didn't sit still, was restless or hyperactive	0	1	2	3
d. Clung to adults or was too dependent	0	1	2	3
e. Was nervous, highstrung, or tense	0	1	2	3
f. Was too fearful or anxious	0	1	2	3
g. Had explosive or unpredictable behaviour	0	1	2	3
h. Had a temper tantrum/s, hot temper, or seemed angry	0	1	2	3
i. Was unhappy, sad, or depressed	0	1	2	3
j. Was withdrawn, didn't get involved with others	0	1	2	3

Figure 2: Teacher-reported behaviour rating scale (TBRS) developed for the current study

Heart rate. Heart rate was used as a physiological measure of the participants' stress. This was measured in units of beats per minute (BPM). A number of studies in the review used heart rate as a measure to explore the stress reducing benefits of nature-based interventions (Gladwell et al., 2012; Annerstedt et al., 2013; Song et al., 2015; Sonntag-Ostrom et al., 2014; Largo-Wight et al., 2016; Berto et al., 2015). Furthermore, heart rate is influenced by both SNS and PNS activity (Porge, 1995), which is beneficial to the current study given that post-traumatic stress appears to effect the functioning of these stress influenced systems. Heart rate data was collected using an oximeter that was operated by the

researcher who was aware of how it worked. This ensured that the device was used accurately in order to obtain reliable results.

Measurement

The two dependent measures were collected at different time points on each day of the study. Figure 3 provides a visual depiction of the different times that measurements were taken across the phases of the study.

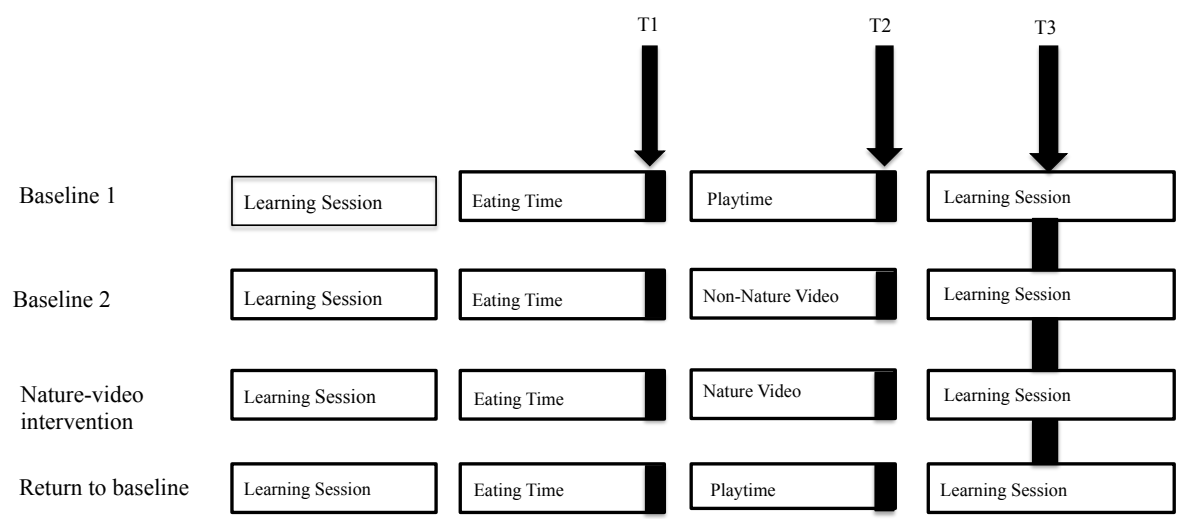


Figure 3: Diagram depicting the time points that repeated measure data was collected across the study.

Heart rate was collected at two different time points on each day of the study. The first time point, time one (T1) was after participants had eaten during their break time. The second time point, time two (T2) was 15 minutes after T1. The activity that took place in the 15 minutes between T1 and T2 varied according to the phase of the study. During Baseline 1, this was participants’ usual school activity, which was their outdoor playtime. In Baseline 2, the participants watched a 10-minute non-nature video. In the nature-video intervention phase participants watched a 10-minute nature-based video. Further information about the content of these videos can be found in the Equipment section below. In the return to Baseline 1 phase, participants returned to their usual school activities, which was their outdoor playtime.

Participants resumed their learning space after T2 heart rate data was collected. Time 3 (T3), occurred 30 minutes after T2. At T3, the participant's home base teacher completed the TBRS. The TBRS was to be completed only by the participant's home base teacher to ensure the data was reliable across the study.

Equipment

Oximeter. An oximeter was used to gather heart rate data. The oximeter provided a digital reading of the participants' BPM as its infrared lights detect the change in capillary blood volume that alters as a result of the heart beating (Feng & Smith, 2014). Oximeters are widely used in research as they are non-invasive and inexpensive, and can accurately measure an individual's heart rate at rest (Iyriboz, Powers, Morrow, Ayers, & Landry, 1991). Although studies in the review used monitors that provided both a heart rate and blood pressure data for the child participants (Berto et al., 2015; Kelz et al., 2013), this required a cuff to be placed around the participant's arm, which may have been uncomfortable. Such issues can also raise ethical concerns when research is conducted with children. The use of a wrist monitor that would provide continuous heart rate data was also considered for the current study. However, after the researcher explored the type of data such devices provided it appeared that it would be complicated for the scope of the current study.

iPad Mini. Participants watched the videos during Baseline 2 and the nature-video intervention phase on an iPad mini (3rd generation) tablet computer. These iPad minis had a light emitting diode (LED) back lit screen that was 200mm diagonally in length (Apple, 2016). Prior to the participants watching the videos the researcher ensured that the brightness was at a level so that the video could be viewed without it needing to be adjusted by the participants. The researcher also made sure the volume was at a level that participants could comfortably listen, however, they were informed that they could make adjustments when

watching the videos if the sound was too quiet or loud for them. An iPad mini was used to watch the videos, because they were available for use at the participating school.

Headphones. Participants wore a set of Moki Poppers Kids On-Ear Headphones that plugged into the iPad mini and allowed them to listen to the sound content of the videos. These were selected because the soft cushioned headphones are worn over the ear to provide comfort for the participants. The manufacturer of these headphones reported that they provide good sound quality (Moki International, 2017).

Non-nature videos. Participants watched a non-nature video during Baseline 2. The videos used were carefully selected to ensure they did not contain any nature content that may have made this an inaccurate comparison phase, yet would be engaging for children of the participants' ages. The researcher previewed all videos and ensured that they would not likely induce a stress response in the participants, or increase heart rate as they were too stimulating (i.e. contained loud noises or flashing pictures).

The researcher found a number of videos available on a YouTube channel called *Kids Health*. These were educational videos that taught children about different parts and functions of the human body. They were presented in a child-friendly cartoon format. Each video was shorter than the required 10-minutes, and therefore two videos were used each day. The researcher made a playlist so that the second video followed the first without any action from the participants. The following videos were watched during each day of the non-nature video phases:

Day 1: *How Your Lungs Work* and *How Your Bones and Skeleton Work*

Day 2: *How Your Immune System Works* and *How Your Brain Works*

Day 3: *How Your Heart Works* and *How Your Digestive System Works*

Day 4: *How Your Ears Work* and *How Your Eyes Work*

Nature videos. The nature-based videos watched during the intervention phase of the study came from an independently owned company called Nature Relaxation™. A subscription to the website provides the user with access to a wide range of nature-based videos that can be accessed through the website. Subscribers can also download an application on a tablet device that the videos can be accessed through. Information on the company's website reports that the ultra-high definition videos are designed to reduce stress, and increase relaxation (Nature Relaxation, 2017).

The researcher previewed a number of different videos in order to select those to be used in the study. Selection of the videos was made on the following basis; firstly, the scene must be dynamic or changing as this was likely to be more interesting for the participants. Secondly, the natural environment that was captured within each video must vary across the eight videos selected. For example, the researcher sought videos that captured different forest, lake, or ocean environments. This could possibly provide further information if results indicated that some natural environments were more stress reducing than others. No human or human voices were in the video. The videos selected for the study are outlined below in regards to which day they were viewed. A short description of the video's content is also provided.

Day 1: *Mountains of Majesty*. This video contained a range of different mountain scenes that were shot at different locations around the United States and Canada. The video contained sounds that were captured from the location of the camera.

Day 2: *Waterfalls of the World Part 2*. This video contained a variety of different waterfall scenes, captured across different locations. The sound content of the video matched the scene being viewed.

Day 3: *Rocky Mountain Wonders*. This video contained different mountain scenes that were captured from a lakeside location. The sound within the video is the natural noise of the lake.

Day 4: *Blue Horizons*. This video contained a number of different ocean-side environments. The distance from the water varied, but the sound of the waves crashing on the shore could still be heard across all scenes.

Day 5: *Golden Forest Relaxation*. This video contained scenes of different forest environments, all captured on days with clement weather. The sound of the leaves moving in the wind can be heard during the video.

Day 6: *Wildlife Wonders: South America*. This video was shot at different locations around South America. The videos captured different animals in their natural locations, such as flamingos and llamas. The sound content matched the scene being viewed.

Day 7: *Dolphin Voyage Relaxation*. This video captured the movement of a pod of dolphins both above and below water. It contained a blend of underwater ocean sounds that was layered with ambient music.

Day 8: *Wonders of Nature*. This video contained a wide range of different nature scenes. These scenes were captured in a rainforest, botanical gardens, and canyon lands. The sound content matched the scene being viewed.

Time of Day/Study Settings

The study was scheduled during school hours around participants' regular learning activities. The researcher considered that reducing inconvenience to participants and minimising disruption of their schooling might increase the likelihood that parents and teachers would consent to their child taking part.

There were a number of different settings that are important to the context of this study. This includes the outdoor space where participants ate their lunch before T1, the

outdoor area that was available to participants during their playtime, the rooms that participants were in when they watched the videos, and the setting for the time between T2 and T3 in which participants were with their home base groups and teacher.

Outdoor eating area. Both Learning Space A and Learning Space B had a large wooden verandah attached to the outside of the building that was covered by an awning. Participants ate their lunch in this area along with the other children in their learning space. Two teachers were responsible for supervising the children during this time. Children were required to sit and eat their lunch in this area for 15 minutes.

Outdoor play area. During their playtime, children were able to use the outdoor areas around the school. This included a playground, a large grass area, and a number of concrete areas with handball and basketball courts.

Breakout rooms. Participants watched both the nature and non-nature videos in a breakout room in their learning space. Breakout rooms are a space that is separated from the main learning area. Learning Space A and Learning Space B had similar breakout rooms. These breakout rooms were approximately 40m² and were separated by a glass door. All breakout rooms had a window that provided a view to a public area outside the school grounds. Furniture in the breakout room included tables and child-sized chairs.

Learning space setting between T2 and T3. Following the playtime, all students in Learning Space A and Learning Space B returned to their learning space for home base time. Each of the five home bases within the learning spaces used an area of the large learning room where they sat with members of their home base, and their home base teacher. During this time, afternoon attendance was taken and the home base teacher would read a story or complete a short activity with the students. This was the situation for the participants Sarah, Reece, and Anna. Although Jake's measurement procedure followed that which is outlined in Figure 2, the time of day that T1, T2, and T3 took place was different for him in comparison

to the other three participants. The setting between T2 and T3 was slightly different for Jake because he would not return to class for home base time. Instead, he completed his regular learning activities, but would still be under the supervision of his home base teacher.

Procedures

Baseline 1. Participants met the researcher inside their learning space after they had eaten their lunch, and the teacher supervising the area had permitted them to leave. They sat at a table while the researcher took their heart rate using the oximeter. The researcher recorded the heart rate reading. Participants then left the learning space and went outside for their regular playtime. No videos were made available to the participants during this time. At the conclusion of the playtime, participants returned to their learning space where they met the researcher at the same table. A five-minute duration occurred between the participants arriving and the researcher taking the heart rate to ensure it reflected *at rest* rates. The researcher recorded the result. Participants walked to the area of the learning space to join their home base. They completed their regular classroom activities for the next 30 minutes. Following this 30 minutes, the home base teacher completed the TBRs.

Baseline 2. Participants met the researcher inside one of the breakout rooms in their learning space after they had eaten their lunch, and the teacher supervising the area had permitted them to leave. Due to the availability of only one breakout room in Learning Space A, Sarah and Reece watched their video in the same room, but they were seated at separate tables. Participants sat on a seat at a table while the researcher took their heart rate. The researcher provided each participant with a pair of child-sized headphones and an iPad mini that had the appropriate video loaded. Participants were informed that they were going to watch the videos for 10 minutes, and to press stop when the researcher re-entered the room. The researcher pressed play on the participant's iPad mini to start the video, and then left the breakout room. The researcher timed a 10 minute period before re-entering the room.

Participants removed their headphones and placed the iPad mini on the table. The participants remained seated until the researcher had taken their heart rates. By this point, the playtime period was over, and participants joined their home base group.

Nature-video intervention. Participants met the researcher inside one of the breakout rooms in their learning space after they had eaten their lunch, and the teacher supervising the area had permitted them to leave. Again, due to the availability of only one breakout room in Learning Space A, Sarah and Reece watched their video in the same room, but they were seated at separate tables. Participants sat on a seat at a table while the researcher took their heart rate. The researcher provided each participant with a pair of child-sized headphones and an iPad mini that had the appropriate video loaded. Participants were informed that they were going to watch the videos for 10 minutes, and to press stop when the researcher re-entered the room. The researcher pressed play on the participant's iPad mini to start the video, and then left the breakout room. The researcher timed a 10 minute time period before re-entering the room. Participants removed their headphones and placed the iPad mini on the table. The participants remained seated until the researcher had taken their heart rates. By this point, the playtime period was over, and participants joined their home base group.

Return to Baseline 1 conditions. The procedures during this phase were a replication of those that occurred during Baseline 1.

Data Summarisation and Analysis

Heart rate. Heart rate data collected at T1 provided a daily baseline of each participant's heart rate, with higher heart rates indicating a higher level of physiological stress. These data were presented on an individual scatter graph for each participant, and analysed against the average heart rate of a child the participant's age, based on the results of a systematic review (Fleming et al., 2011). This gave an indication about the participant's daily level of stress in relation to an 'average' child without post-traumatic stress symptoms.

Heart rate data collected at T2 were presented on an individual line graph for each participant. The results on this graph indicated the participants' heart rate *after* the different activities (i.e. playtime, non-nature video, or nature video) that occurred between T1 and T2. Higher heart rate (as measured by BPM) indicated a higher level of stress.

A difference score (T2-T1) was calculated to explore any changes in the participants' heart rate that occurred *between* T1 and T2. The difference scores were presented on an individual line graph for each participant. A difference score of zero indicated that there was no change in the participant's heart rate between T1 and T2 (i.e. $T2=T1$), a difference score above zero indicates that heart rate increased (i.e. T2 was higher than T1), and a difference score below zero indicates that heart rate decreased (i.e. T2 was lower than T1). A similar method was used by Largo-Wight et al. (2016) to explore the difference in heart rate before and after participants listened to a nature sound, classical music, or sat in silence.

Teacher-reported behaviour. An overall TBRS score was provided for each participant on each day of the study. Possible scores on the TBRS ranged from zero to 30, with higher scores indicating that the participant's home base teacher reported a higher frequency and intensity of stress related behaviours between T2 and T3. The scores on the TBRS were presented on an individual line graph for each participant. Using the applicable items on the TBRS, a description of the behaviours that most commonly occurred during each phase is provided for a qualitative account of the participant's behaviours. The wording of the items has been changed for descriptive purposes but retain the same meaning (e.g. Item D *clung to adults or was too dependent* was described as *clingy behaviour*).

A visual analysis of level, trend, and variability was conducted on the graphs as appropriate for single-subject designs (Blampied, 1999; 2014). The level relates to the data sets position relative to the Y-axis. Level changes between phases indicated that dependent measures (heart rate and teacher-reported behaviour) were either higher or lower in certain

phases. The trend is the direction that the data line is going. In the current study, an accelerating trend indicated that heart rate or teacher-reported behaviours were increasing, and a decelerating trend indicated that they were decreasing. Variability refers to how much the data set fluctuates within a phase. High variability indicated that the dependent variable did not have a stable response to the nature-video intervention, while low variability indicated a stable response from the dependent measure.

Social Validity

An additional element to this study was the assessment of social validity. There were two different parts to this process. Part 1 was conducted in relation to the intervention that took place with the participants. Part 2 was to explore whether the videos could be used as a stress reducing aid within the learning spaces. These parts are described below.

Part 1: Phase one was conducted after the nature-video intervention phase.

Participants completed a brief semi-structured interview that explored their thoughts and experiences of the nature-based intervention. The researcher met with children individually in a breakout space at a time that was suggested by the participant's home base teacher.

Participants were asked questions such as "Did you like watching the videos?" and "How did you feel after watching the videos?" The interview was audio recorded to ensure that data collection was accurate. A copy of all questions asked during this interview can be found in Appendix M.

Part 2. The second phase of social validity was conducted with the permission of all five teachers in both Learning Space A and Learning Space B. The researcher provided both classes with a beanbag, a pair child-sized headphones, and a tablet computer that could access the nature videos via the Nature Relaxation™ application. Teachers set up an area where the students could self-select to watch the videos. The researcher spoke to all students in both Learning Space A and Learning Space B about the intended function of watching the

videos (i.e. to reduce stress), and demonstrated how to turn the tablet on and access the videos. Each learning space had the resources to set up the area for a period of 10 consecutive school days. No data were collected during this period. Following the 10-day period teachers completed a brief semi-structured interview to obtain information regarding their experience of having the videos available for use in their learning space. To explore how the frequency of use, teachers were asked questions such as “How often were the nature videos watched by any student in your class?” Teachers were also asked to report how often the children who participated in the study accessed the videos. To explore if the videos were effective in reducing students’ stress, teachers were asked questions such as “How effective do you feel the nature videos were in reducing children’s restlessness?” A copy of all questions asked can be found in Appendix N. The interview was audio recorded to ensure accuracy of data collection.

A summary of social validity findings is provided at the end of the results section. A general deductive method used for the analysis of the social validity data (Thomas, 2006) could not be used for the information provided by the interviews was not large enough for such methods to take place. Therefore, a brief summary of the comments made by participants and teachers is provided at the end of the Chapter 4.

Chapter 4

Results

The study was completed in Term 1 of the school year. Although all ethical procedures were followed, there were exceptions to the planned study method. Issues arose regarding participant recruitment, participants being absent from school, school events, and the researcher being unavailable to collect heart rate data on particular days. These circumstances resulted in delays in beginning the study, and a number of days where the study could not take place. In an effort to complete as many planned sessions as possible for each participant, the sessions ended up taking place over a period of 28 consecutive school days. Overall, only one participant was able to complete all 20 planned sessions. Information is provided at the beginning of each individual's results section in regards to missed days and the number of days completed within each experimental phase. The Events Diary (Appendix O) gives an overview of the 28-day period that the study took place, and indicates the days that data could not be collected. As Day 28 was the final day of Term 1, any missed days could not be completed before the participants were away on school for the school holiday two-week break. The study could not be continued after the break because a large gap between data collection may have increased the likelihood that other variables or events outside the study may have influenced the participants' data (Morgan & Morgan, 2014). These issues and their potential impact on the results are discussed further in Chapter 5.

Sarah

Data collection for Sarah began on Day 1 of the 28 consecutive day period. She completed the following number of sessions in each experimental phase: four days for Baseline 1, four days for Baseline 2, eight days for the nature-video intervention phase, four days return to baseline. On Days 5, 10, 11, 15, and 19 the researcher was unable to be at the

school. On Days 12, 13, and 14, teachers from both Learning Space A and Learning Space B were away on camp and alternate learning space activities were organised within the school. This meant that Sarah would not be with her home base teacher at T3. To ensure reliability of the teacher behaviour reports, the teacher that was supervising Sarah at this time was not asked to complete the TBRs.

Heart rate (T1). Sarah's heart rate at T1 remained relatively stable across most days of the study, and was around the median resting heart rate for children her age of 90 BPM (Figure 4). Days 6, 23, and 24 are an exception to this.

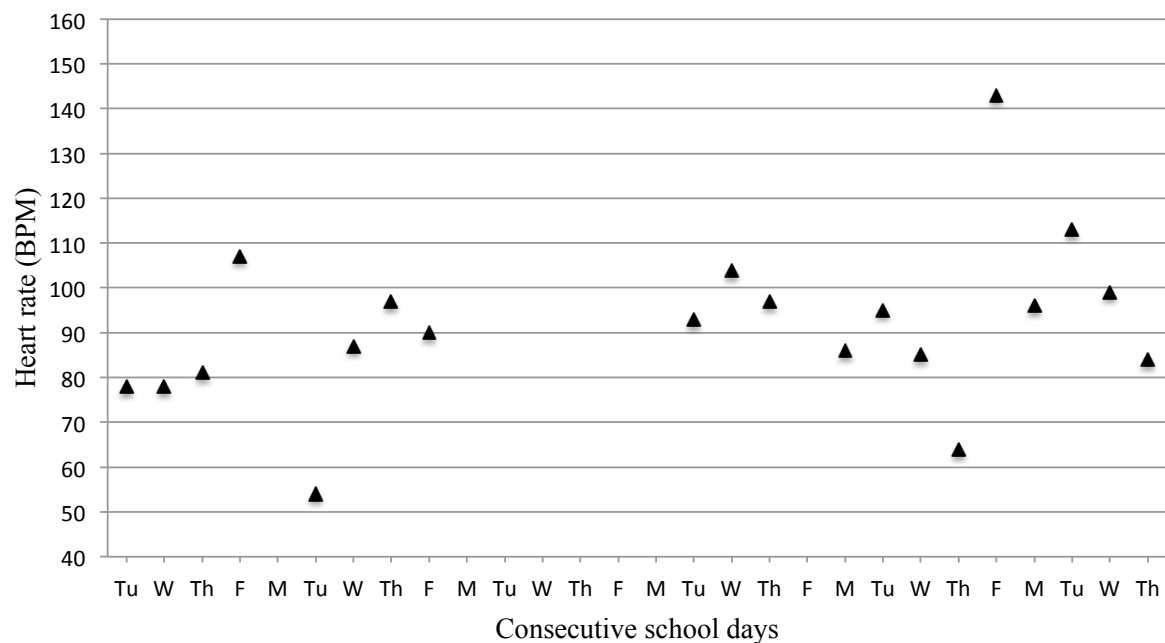


Figure 4: Sarah's heart rate at T1 throughout the study. BPM = beats per minute.

Heart rate (T2). Sarah's T2 heart rate data are presented in Figure 5. This variability across all data sets indicates that Sarah's heart rate at T2 was mostly unstable across all phases of the study. There were three days during the nature-video intervention phase (Days 20-23) that her heart rate at T2 was stable. Across all phases, Sarah's heart rate at T2 was at a similar level.

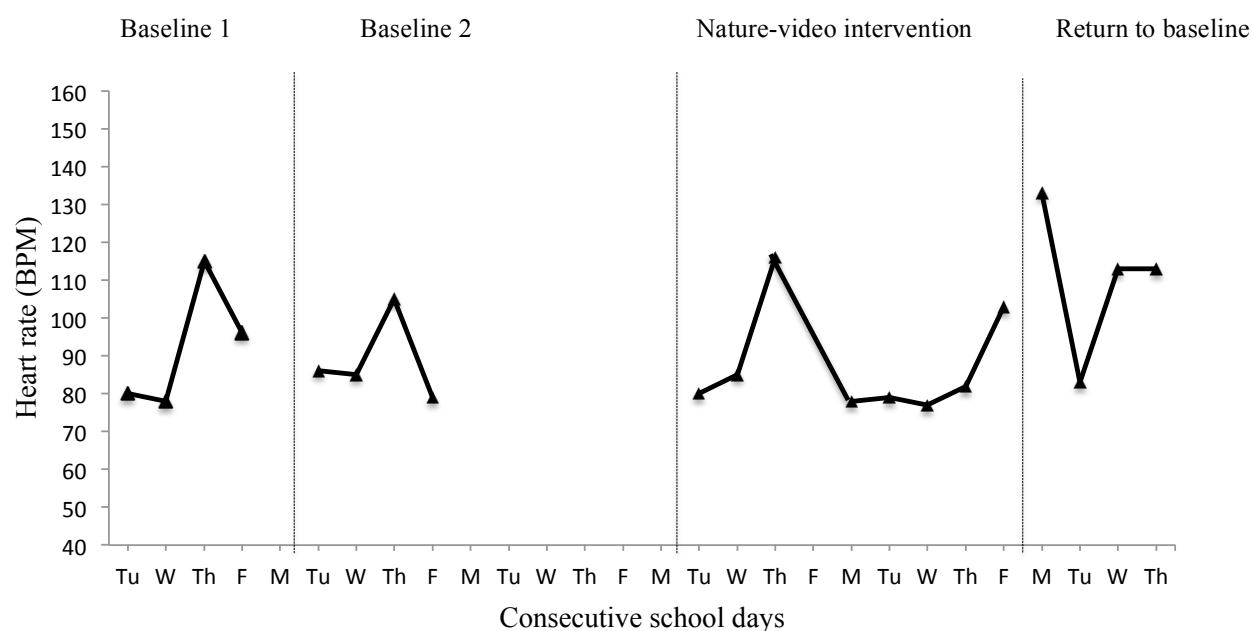


Figure 5: Sarah's heart rate at T2 across Baseline 1, Baseline 2, nature-video intervention, and return to baseline. BPM= beats per minute.

Heart rate difference. Figure 6 displays Sarah's heart rate difference scores across the different phases of the study. During Baseline 1, the heart rate difference score was above zero on three of the four days, and below zero on the remaining day. As such, there was only one day during Baseline 1 that Sarah's heart rate decreased from T1 to T2. Heart rate decreased from T1 to T2 on two of the four days during Baseline 2. Sarah's heart rate decreased from T1 to T2 on the majority (six out of eight) of the days during the nature-video intervention phase. There was one day during the four-day return to baseline phase where Sarah's heart rate decreased from T1 to T2.

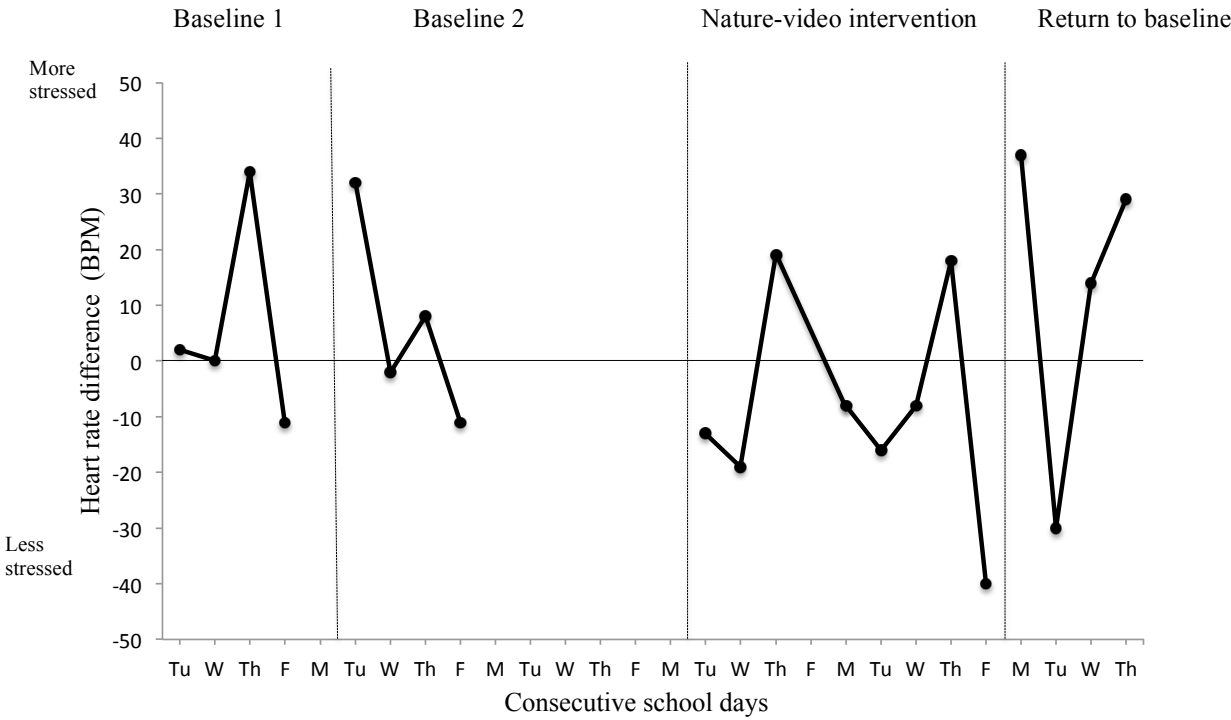


Figure 6: Heart rate difference between T1 and T2 for Sarah across Baseline 1, Baseline 2, nature video intervention, and return to baseline. BPM=beats per minute

Teacher behaviour rating. Sarah's TBRS scores at T3 were reasonably low across all phases of the study (Figure 7).

During the four days of Baseline 1, her scores ranged between two and five on a scale of zero to 30. Sarah's home base teacher reported restless or hyperactive behaviour between T2 and T3 on three of the four days. Inattentive and unhappy or sad behaviours were reported on two of the four days. Nervous behaviours were reported on one of the four days.

During the four days of Baseline 2, Sarah's TBRS scores at T3 ranged between one and 10, and showed an accelerating trend. This indicated that her stress related behaviours reported at T3 were increasing across this four-day period. Sarah's home base teacher reported inattentive, and restless or hyperactive behaviours between T2 and T3 on three of the four days. Clingy behaviours were reported on two of the four days. Nervous, anxious, and unpredictable or explosive behaviours were reported on one of the four days.

Sarah's TBRS scores at T3 were variable over the eight-day nature-video intervention phase, and ranged between zero to 12. Sarah's home base teacher reported inattentive behaviour on four of the eight days. Restless or hyperactive behaviour between T2 and T3 was reported on three of the eight days. Unhappy or sad behaviour was present on two of the eight days. Nervous and anxious behaviour was present on one of the eight days.

During the return to baseline phase, Sarah's TBRS scores at T3 ranged between one and three across the four-day period. Inattentive behaviours between T2 and T3 were reported on three of the four days, and restless or hyperactive behaviours were reported on two of the four days.

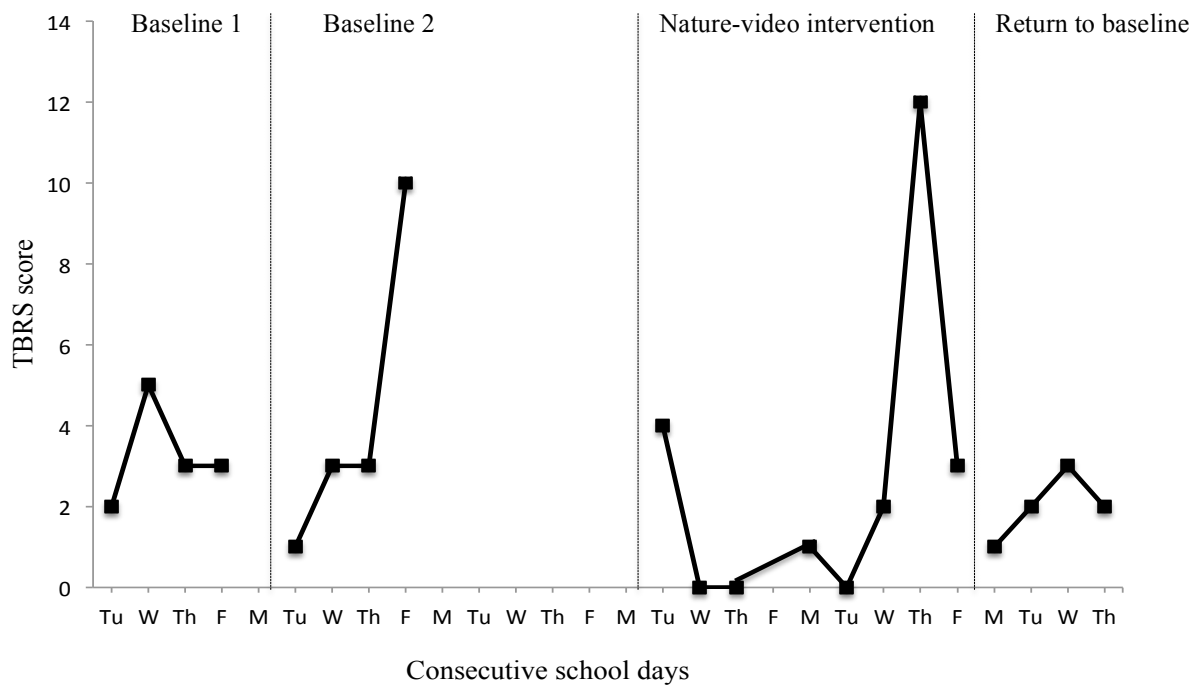


Figure 7: Scores on the teacher-reported behaviour rating scale at T3 for Sarah across Baseline 1, Baseline 2, nature-video intervention, and return to baseline. TBRBS= teacher-reported behaviour rating scale

Reece

Data collection for Reece began on Day 1 of the 28 consecutive day period. He completed the following number of sessions in each experimental phase: four days for Baseline 1, three days for Baseline 2, eight days nature-video intervention phase, and four days for return to baseline. On Days 5, 10, 11, 15, and 19 the researcher was unable to be at the school. On Days 12, 13, and 14, teachers from both Learning Space A and Learning Space B groups were away on camp and alternate learning space activities were organised within the school. This meant that Reece would not be with his home base teacher at T3. To ensure reliability of the teacher behaviour reports, the teacher supervising was not asked to complete the TBRBS. Reece was also absent from school on Day 6 due to illness.

Heart rate (T1). Reece's T1 heart rate data showed wide variability across the study (Figure 8). It fluctuated above and below the average heart rate of 90 BPM for children his age.

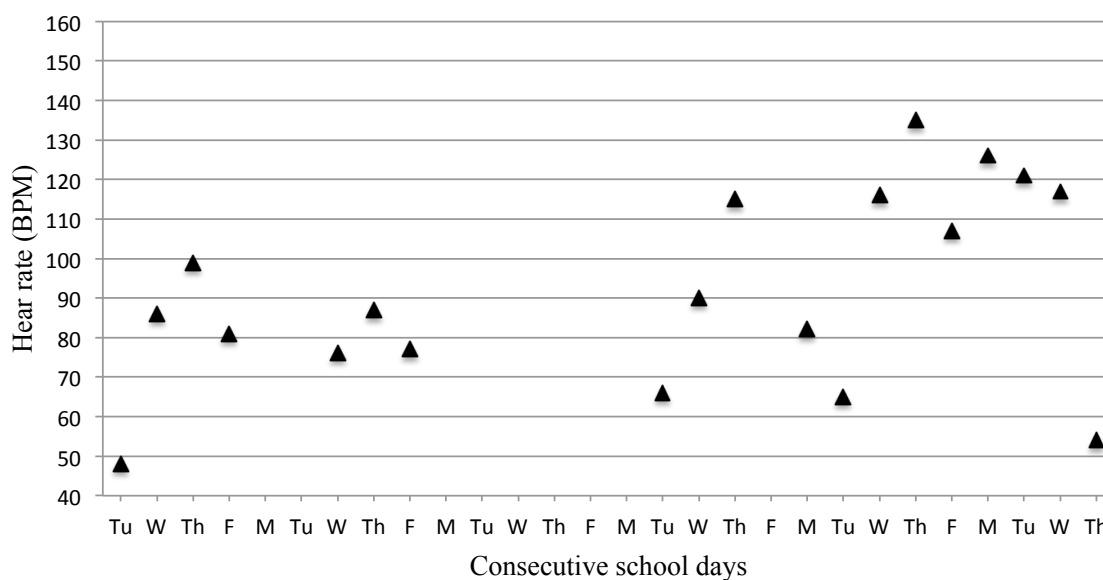


Figure 8: Reece's heart rate at T1 throughout the study. BPM=beats per minute.

Heart rate (T2). Reece's heart rate at T2 is presented in Figure 9. His heart rate was higher at T2 during the baseline phase in comparison to other phases across the study. Across the eight days of the nature-video intervention phase, Reece's heart rate at T2 was stable. There was no difference between the levels of the data set in Baseline 2 in comparison to the nature-video intervention phase.

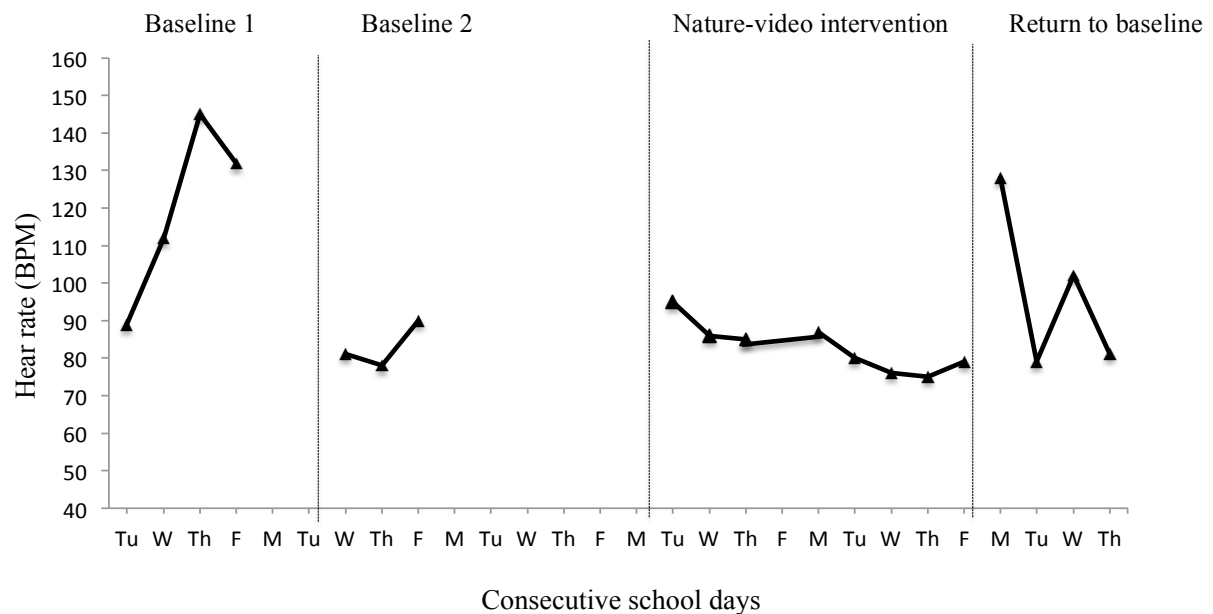


Figure 9: Reece's heart rate at T2 across Baseline 1, Baseline 2, nature-video intervention, and return to baseline. BPM=beats per minute.

Heart rate difference. Reece's heart rate difference data is presented in Figure 10.

Heart rate difference scores are higher during the Baseline 1 phase in comparison to all other phases. During Baseline 1, the heart rate difference score was above zero on all four days.

This indicates that Reece's heart rate increased from T1 to T2 on all four days. During Baseline 2, Reece's heart rate decreased from T1 to T2 on one of the three days. Reece's heart rate decreased between T1 and T2 on the majority (five out of eight) of days during the nature-video intervention phase. During return to baseline, Reece's heart rate decreased from T1 to T2 on two of the four days.

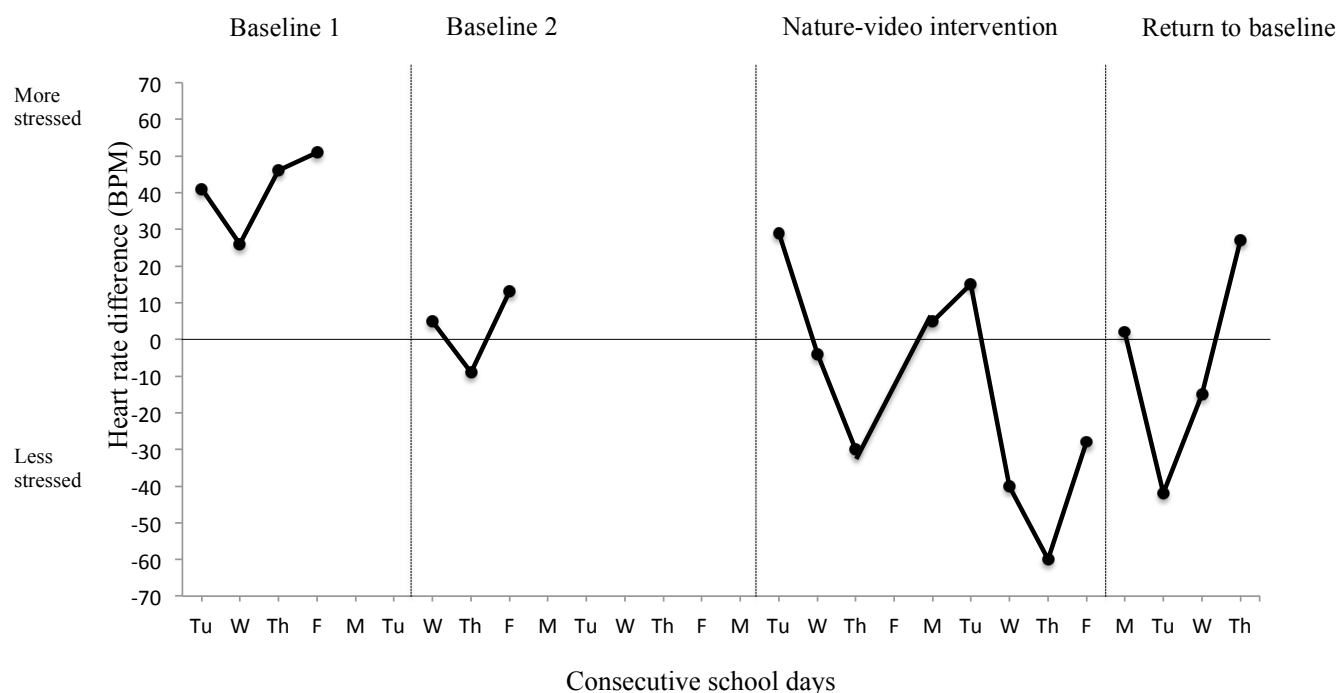


Figure 10: Heart rate difference between T1 and T2 for Reece across Baseline 1, Baseline 2, nature-video intervention, and return to baseline. BPM=beats per minute.

Teacher behaviour rating. Reece's TBRS scores at T3 show no discernible trends or changes in level, and were highly variable across all phases of the study (Figure 11).

During Baseline 1, Reece's scores on the TBRS at T3 ranged between four and eight on a scale of zero to 30. Reece's home base teacher reported inattentive and nervous behaviours between T2 and T3 on all four of the days during Baseline 1. Restless or hyperactive and clingy behaviours were reported on three of the four days. Sad or unhappy, nervous and anxious behaviour was reported on two of the four days.

During Baseline 2, Reece's TBRS scores at T3 ranged between zero and six. Clingy, nervous and anxious behaviour was reported on two of the three days. Inattentive and restless or hyperactive behaviour was reported on one of the three days.

Reece’s TBRs scores at T3 ranged between zero and 10 during the eight-day nature-video intervention phase. Reece’s home base teacher reported inattentive, restless or hyperactive, clingy, and nervous or anxious behaviour between T2 and T3 on four of the eight days. Nervous and anxious behaviours were present on two of the eight days.

During the return to baseline phase, Reece’s TBRs scores at T3 ranged between zero and six. Reece’s home base teacher reported inattentive behaviour between T2 and T3 on two of the four days, and clingy, nervous and anxious behaviours on one of the four days.

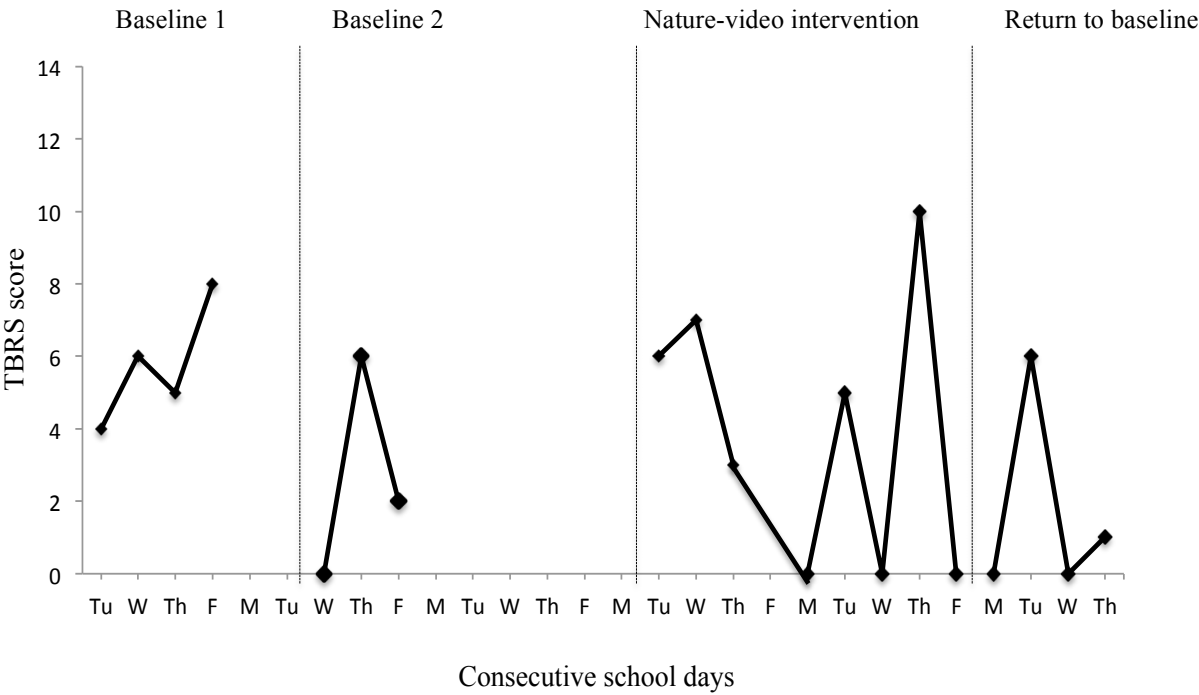


Figure 11: Scores on the teacher-reported behaviour rating scale at T3 for Reece across Baseline 1, Baseline 2, nature-video intervention, and return to baseline. TBRs= teacher reported behaviour rating scale.

Anna

Data collection for Anna began on Day 4 of the 28 consecutive days. She completed the following number of sessions in each experimental phase: three days for Baseline 1, three days for Baseline 2, eight days for the nature-video intervention phase, and two days for the return to baseline phase. On Days 5, 10, 11, 15, and 19, the researcher was unable to be at the school. On Days 12, 13, and 14, Anna’s home base teacher was away on camp and therefore

unavailable to complete the behaviour rating form at T3. Anna was also absent from school on Day 27 due to illness.

Heart rate (T1). Anna’s heart rate at T1 was variable across the study (Figure 12). It was generally below the average rate for children her age, which is 95 BPM.

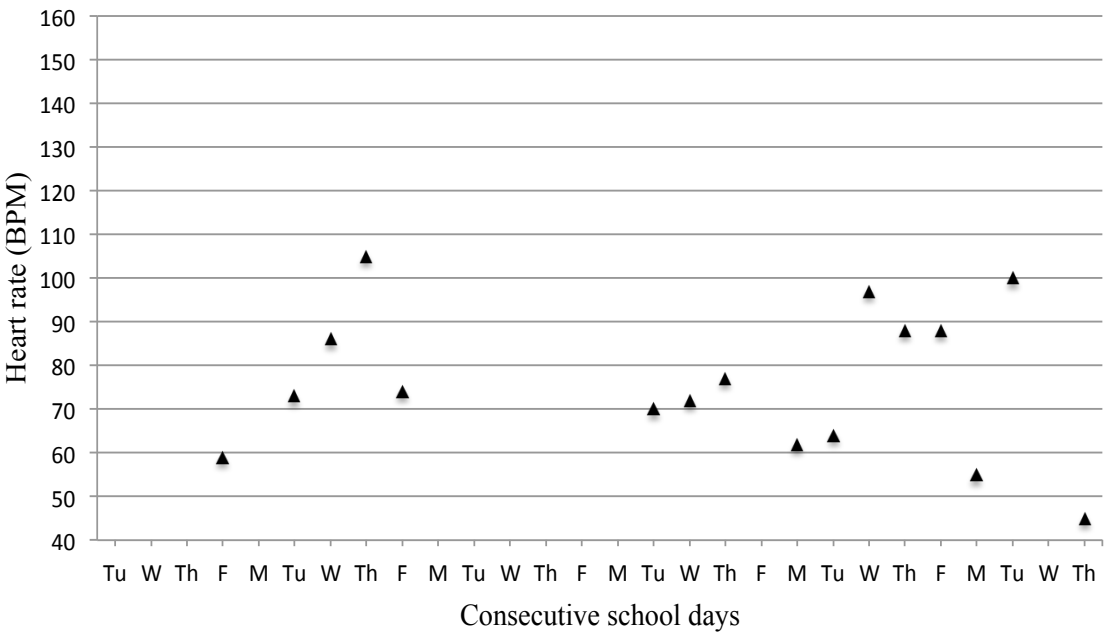


Figure 12: Anna’s heart rate at T1 throughout the study. BPM=beats per minute.

Heart rate (T2). Anna’s T2 heart rate data is presented in Figure 13. Heart rate was lower across Baseline 2 and nature-video intervention in comparison to Baseline 1 and return to baseline. There is no difference in the level of the data set when comparing Baseline 2 to the nature-video intervention. This indicates that Anna’s stress levels were similar after watching a non-nature video and a nature video.

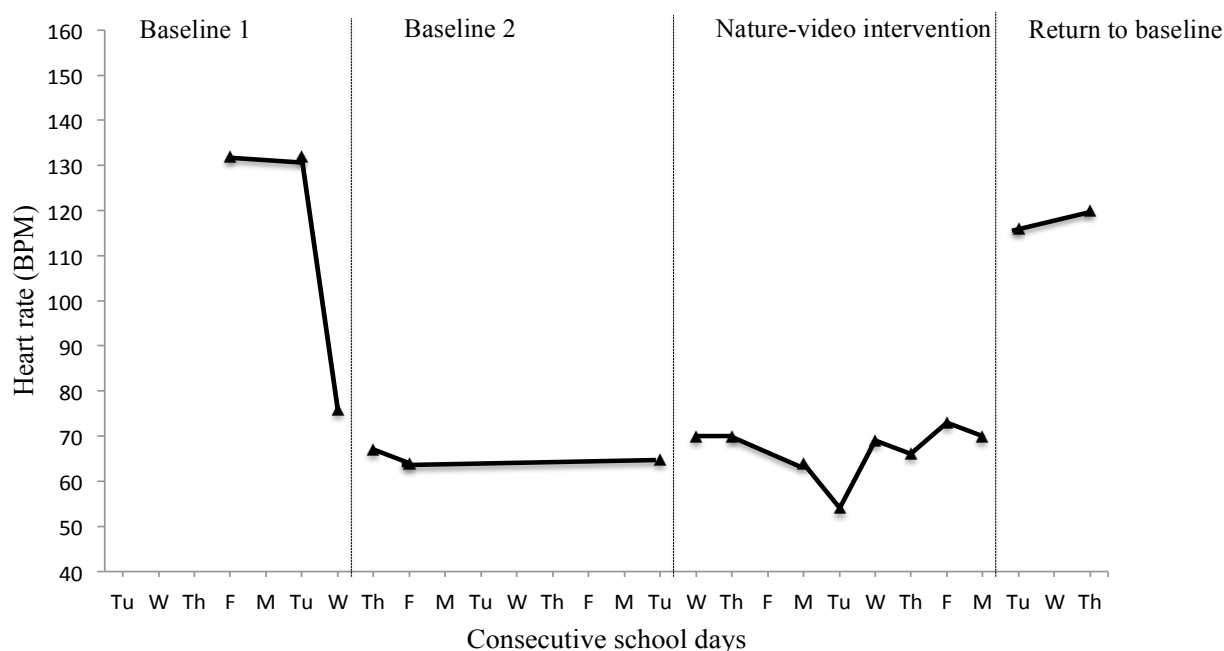


Figure 13: Anna's heart rate at T2 across Baseline 1, Baseline 2, nature-video intervention, and return to baseline. BPM=beats per minute.

Heart rate difference. Heart rate difference data is presented in Figure 14. During Baseline 1, Anna's heart rate difference score was above zero on two of three days. There was one day during Baseline 1 that her heart rate decreased from T1 to T2. During Baseline 2, all days produced a difference score below zero indicating that Anna's heart rate decreased from T1 to T2 on all three occasions. Heart rate difference scores during the nature-video intervention phase were at a similar level to that in Baseline 2, and there were six out of eight days that Anna's heart rate reduced from T1 to T2. In the return to baseline phase, heart rate difference was above zero for both days, indicating that her heart rate increased between T1 and T2.

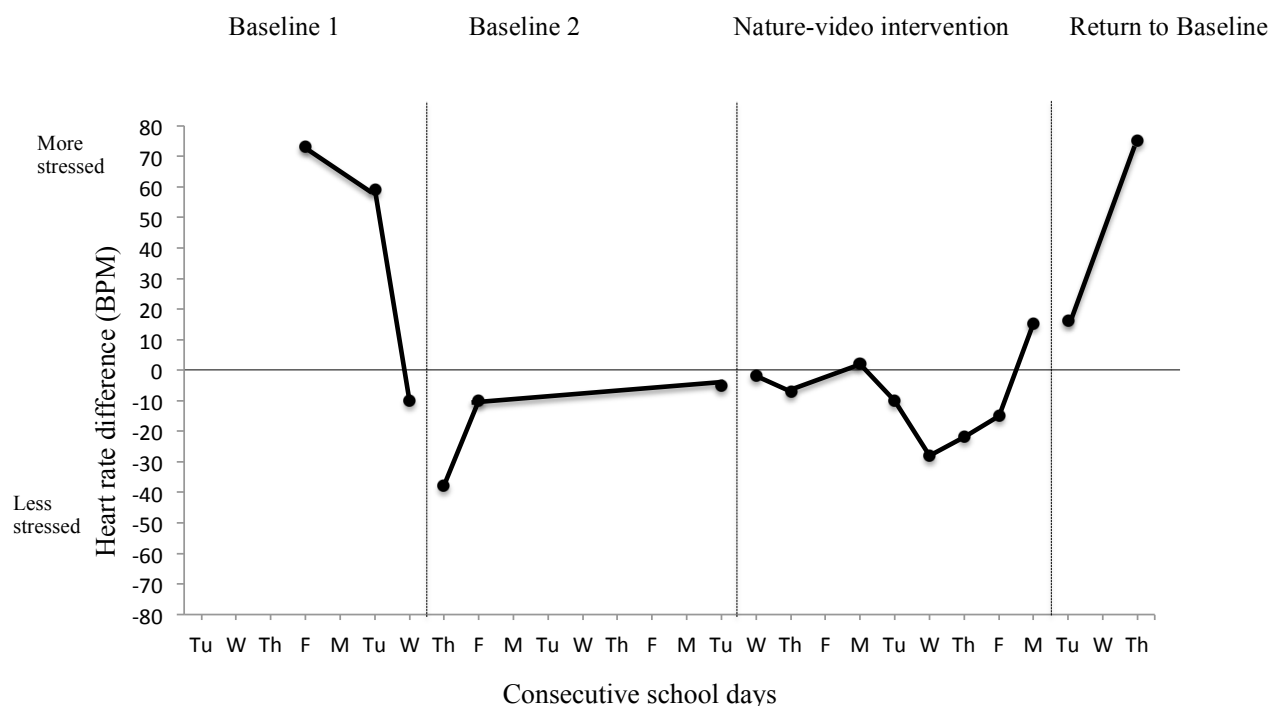


Figure 14: Heart rate difference between T1 and T2 for Anna across Baseline 1, baseline 2, nature-video intervention, and return to baseline. BPM=beats per minute.

Teacher behaviour rating. Anna's TBRS at T3 scores are presented in Figure 15.

There is a decelerating trend in both Baseline 1 and Baseline 2, suggesting that her teacher-reported stress behaviours between T2 and T3 were decreasing over these days. Anna's teacher-reported behaviours remain at a low level over the nature-video phase and return to baseline phase.

During Baseline 1, Anna's TBRS scores at T3 ranged between five and 19 on a scale of zero to 30. Her home base reported anxious and unhappy or sad behaviour between T2 and T3 on all three days. Clingy and nervous behaviour was present on two of the three days.

During Baseline 2, Anna's TBRS scores at T3 ranged between one and five. Her home base teacher reported anxious and unhappy or sad behaviour between T2 and T3 on two of the three days.

Over the eight days of the nature-video intervention phase, Anna's TBRS scores at T3 ranged between zero and nine. Her home base teacher reported the presence of unhappy or

sad behaviour between T2 and T3 on three of the eight days. Clingy, nervous, and anxious behaviours were present on two of the eight days.

During the return to baseline phase, Anna’s TBRs scores at T3 were one and four. Her home base teacher reported anxious behaviour between T2 and T3 on both of these days. Unhappy or sad behaviour was reported on one of the two days.

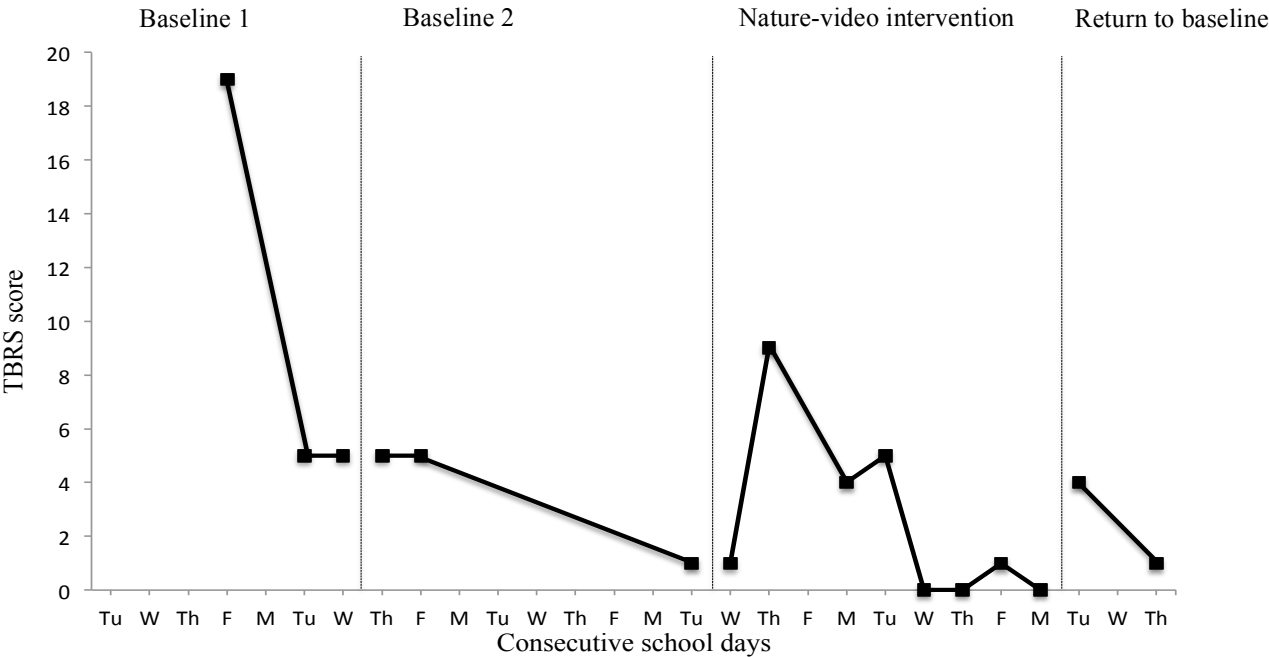


Figure 15: Scores on the teacher-reported behaviour rating scale at T3 for Anna across Baseline 1, Baseline 2, nature-video intervention, and return to baseline. TBRs= teacher-reported behaviour rating scale.

Jake

Data collection for Jake began on Day 9 of the 28 consecutive day period. He completed the following number of sessions in each experimental phase: five days Baseline 1, zero days for Baseline 2, seven days nature-video intervention phase, and three days for return to baseline phase. Jake was the last participant to be recruited, which delayed his commencement of the Baseline 1 phase. The researcher decided to remove the Baseline 2

phase in order to ensure enough days were available for him to complete the nature-video intervention. On Days 10, 15, and 19, the researcher was unable to be at the school. Jake was absent from school on Days 12 and 16 due to illness. On Day 9, T2 heart rate data could not be collected, as Jake was involved in a playground incident that required him to spend time with the Deputy Principal. This delayed Jake's return to class, and due to his behaviour at this time, it would have been inappropriate for the researcher to take his heart rate. Similarly on Day 14, Jake's arrival back to class was delayed by approximately 30 minutes because he was with the duty teacher, who was sorting out a playtime incident. Because of this, the researcher did not collect T2 heart rate data on this day; however, on both of these days, Jake's teacher still completed the TBRs, but this was 30 minutes after the usual T3 time.

Heart rate (T1). Jake's T1 heart rate data is presented in Figure 16. It was variable across the study, and was usually the average heart rate of children his age which is 95 BPM. Jake's heart rate was particularly at 175 BPM on Day 25.

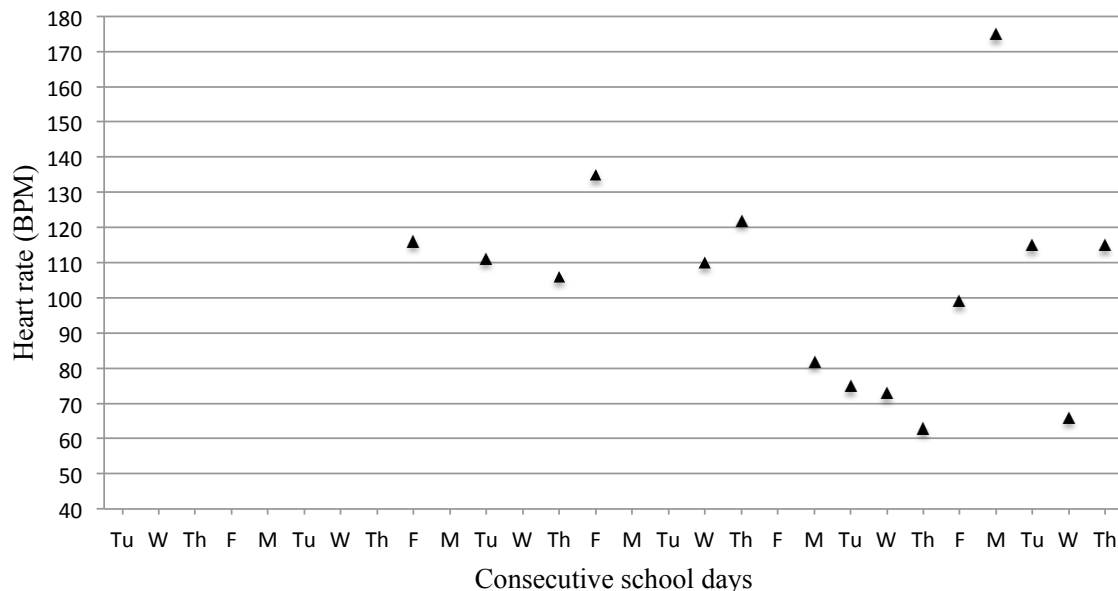


Figure 16: Jake's heart rate at T1 throughout the study. BPM=beats per minute.

Heart rate (T2). Jake's T2 heart rate data is presented in Figure 17. The data set is lower during the nature-video intervention phase in comparison to the Baseline 1 and return to baseline phases. This indicates that Jake's heart rate was lower after he watched the nature video in comparison to after his playtime. Jake's heart rate at T2 was stable across three days (Day 18, 20, 21) during the nature-video intervention phase.

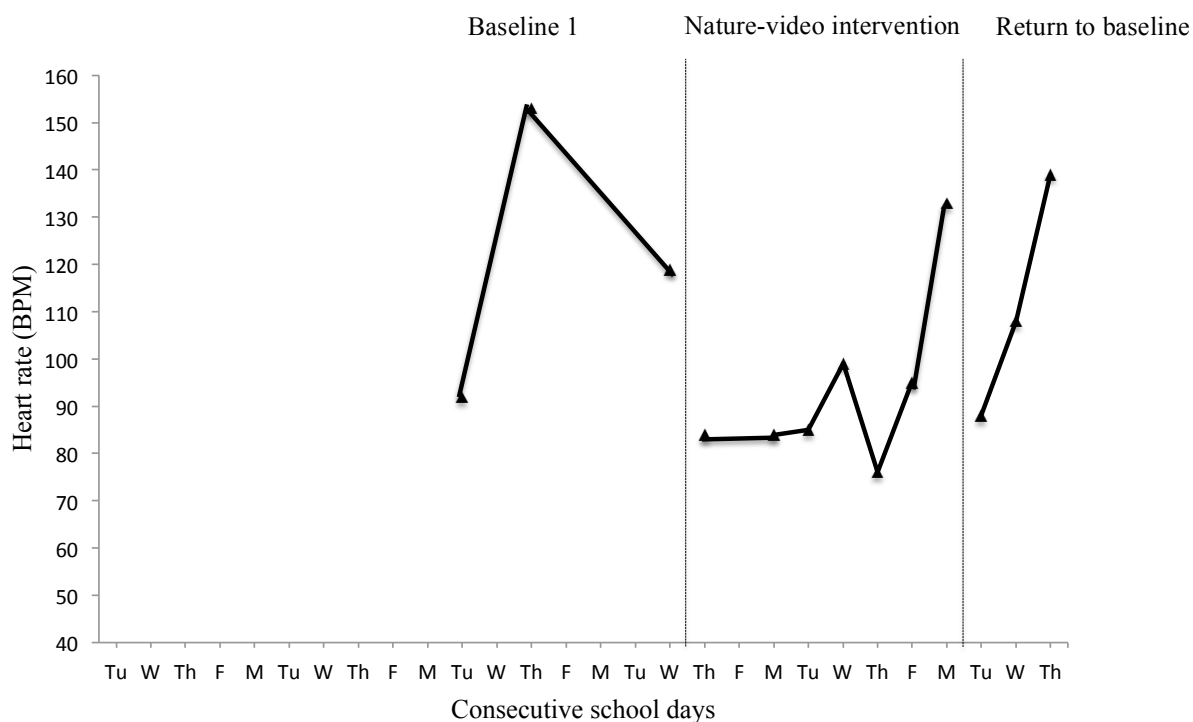


Figure 17: Jake's heart rate at T2 across Baseline 1, nature-video intervention, and return to baseline. BPM=beats per minute.

Heart rate difference. Figure 18 displays Jake's heart rate difference data. During Baseline 1, Jake's heart rate difference was below zero on one of the three days. Jake's heart rate difference was below zero on only three out of the seven days during the nature-video intervention phase. Jake's heart rate reduced between T1 and T2 on one day of the three days during return to baseline.

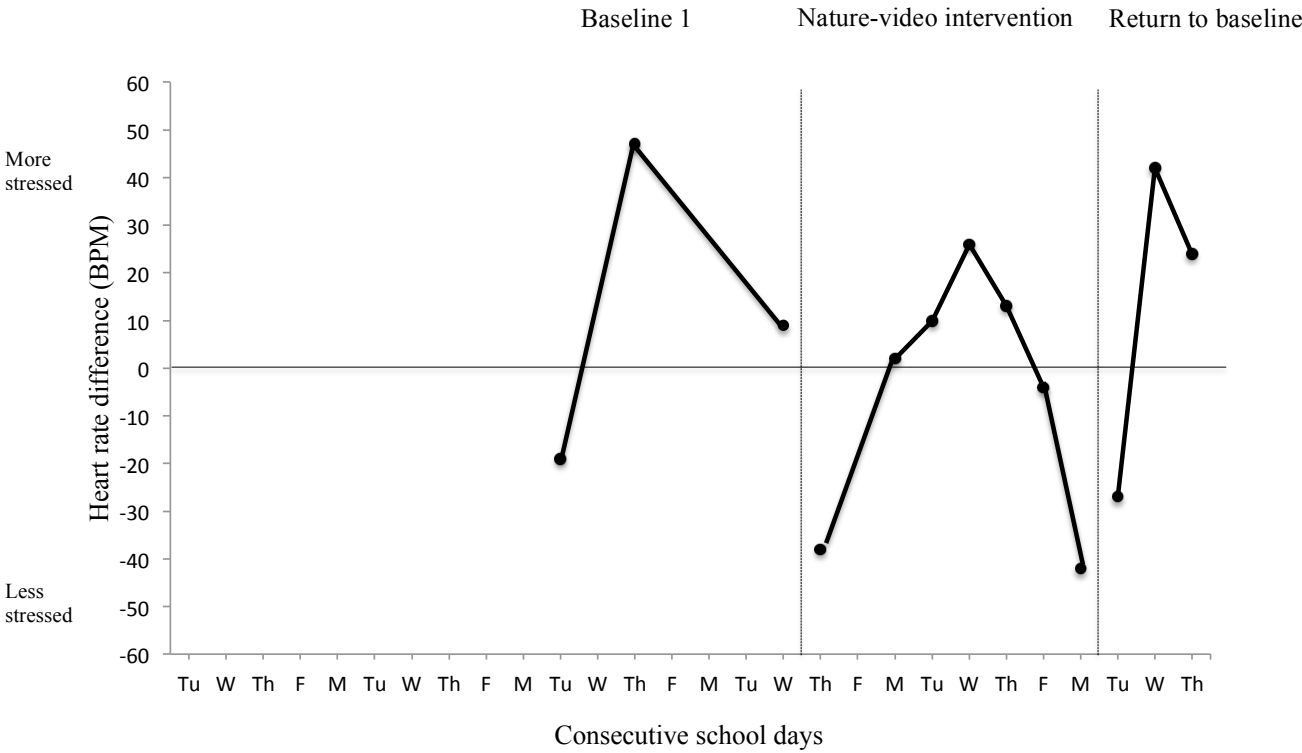


Figure 18: Heart rate difference between T1 and T2 for Jake across Baseline 1, Baseline 2, and return to baseline.

Teacher behaviour rating. Jake’s TBRS score at T3 are presented in Figure 19. This graph showed a steep decelerating trend during Baseline 1. This indicates that Jake’s teacher-reported behaviours were reducing over this five-day period. His TBRS scores remained relatively low over the nature-video intervention phase and return to baseline.

During Baseline 1, Jake’s TBRS scores at T3 ranged between three and 22, on a scale of zero to 30. Jake’s home base teacher reported a number different behaviours between T2 and T3 over this phase. Restless or hyperactive, inattentive, and explosive or unpredictable behaviours were present on all five days across the baseline phase. Angry and argumentative behaviour was present on four of the five days. Unhappy or sad and withdrawn behaviour was present on two of the five days. Nervous, anxious, tantrum behaviours were present on one day of the study.

In nature-video intervention phase, Jake's TBRS scores at T3 ranged between one and seven. His home base teacher reported argumentative and restless or hyperactive behaviour between T2 and T3 on six of the seven days. Inattentive and withdrawn behaviour was present on five of the seven days. Explosive or unpredictable behaviour was reported on one of the seven days.

Jake's TBRS scores during return to baseline remained low and ranged between 2 and 12. Inattentive and restless or hyperactive behaviour between T2 and T3 was reported on all three days. Explosive and argumentative behaviour was reported on one of the three days.

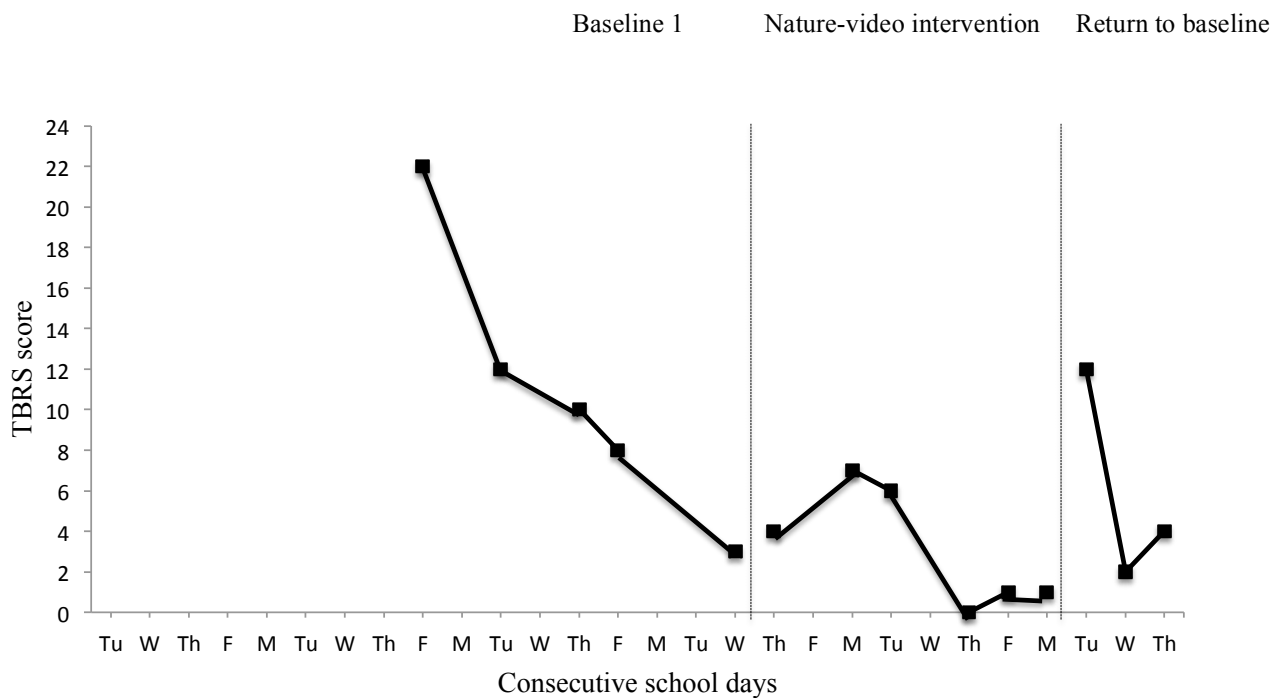


Figure 19: Scores on the teacher-reported behaviour rating scale at T3 for Jake across Baseline 1, Baseline 2, nature-video intervention, and return to baseline. TBRS=teacher-reported behaviour rating scale.

Summary of Results

During Baseline 1, heart rate difference data showed no discernable pattern and all participants, excluding Reece, had at least one day that their heart rate difference was below zero (i.e. heart rate reduced from T1 to T2). Teacher-reported behaviours were variable for Sarah and Reece and showed no discernable trend. Anna and Jake's teacher-reported behaviour data showed a decelerating trend over the Baseline 1 phase. This indicates their teacher-reported behaviours between T2 and T3 were decreasing over the days during this phase.

Reece and Anna's heart rate at T2 was lower during Baseline 2 than it was at Baseline 1, whereas Sarah's heart rate at T2 was at a similar level across Baseline 1 and Baseline 2. This indicates that Reece and Sarah's heart rate was lower after they watched the non-nature video than it was after their regular playtime activities, whereas Sarah's heart rate at a similar BPM after the two activities. Reece and Anna's heart rate difference scores were lower across Baseline 2 in comparison to Baseline 1. Sarah's heart rate difference score were the same across the two phases. This indicates that Reece and Sarah's heart rate reduced more between T1 and T2 when they watched the non-nature video in comparison to their regular play activity. For Sarah, there was no difference between the activities. All three participants that completed Baseline 2 had days that their heart rate decreased from T1 to T2. During Baseline 2, Sarah's teacher-reported behaviour showed an accelerating trend, indicating they were increasing over this phase, while Anna's teacher-reported were decreasing over this period. All three participants' teacher-reported behaviours were low across Baseline 2.

During the nature-video intervention phase, heart rate at T2 was at a similar level as it was during between Baseline 2 for Sarah, Reece and Anna. This indicates that for these participants, heart rate was at a similar BPM after they watched a non-nature video in comparison to a nature video. All participants had a period of days that their T2 heart rate

remained stable during the nature-video intervention phase. Furthermore, heart rate difference was below zero for the majority of days during the nature-video intervention phase for Sarah, Reece and Anna. For Jake, T2 heart rate was lower during the nature-intervention phase than it was in the Baseline 1 phase, and his heart rate difference was above zero on the majority of the days during the nature video intervention phase. Teacher-reported behaviours remained low during the nature-video phase, and all four participants had at least one day that their teacher-reported behaviours were zero.

For Anna, heart rate at T2 was comparatively higher during return to baseline than it was across other phases. For the other participants, heart rate at T2 during return to baseline remained at similar BPM in comparison to other phases. Heart rate difference scores were below zero on at least one day for all Sarah, Reece and Jake, but not Anna. Teacher-reported behaviour remained low across the return to baseline phase for all participants.

Additional Analysis for Teacher-Reported Behaviour

An additional analysis was conducted to further explore the TBRS data. This was completed, as teacher-reported behaviours were generally low for all participants across the study. Blampied (1999) noted that floor effects might occur when the measure selected to gauge the behaviour is not sensitive enough to detect changes that may be occurring. Due to this, additional graphs were created that separated the items on the TBRS that pertained to internalising and externalising behaviours. Another additional graph that displayed only the item that related to inattentive behaviour (Item B) was also created, as this behaviour appeared to be common behaviour across all participants during the study. These additional analyses did not generate any results were more significant than they were when all TBRS items were combined for a total score. A copy of these graphs can be found in Appendix Q and R.

Social Validity

Part 1. All four participants reported that they liked watching the video. Anna reported that she *“liked the sounds that were in the videos”* and both Jake and Sarah reported that they liked the videos that contained animals. Contradictorily, participants reported that the videos went for too long, and suggested they were boring at times. Sarah for example commented that she *“didn’t like the forest one because it was a bit too slow, and I don’t know, it’s a bit too boring to just watch forests and trees”*. Jake also commented that *“the camera didn’t move enough”* during the video. Three of the participants made comments about the calming effects of the video. When asked how they felt after watching the video, both Reece and Sarah said *“calm”*, while Anna commented that she *“liked the calming noises”* that were in the video. Three of the participants were able to identify occasions they would watch the videos again. Reece commented *“I would watch them again, I don’t know, maybe when I’m feeling angry”*. Sarah reflected that she would watch them if *“feeling sad if something bad happened”*. Anna reported that she would watch them because they *“keep her calm”*. Overall, the participants made positive comments about the videos, even though they also made the opposing comments that they found them boring at times. Participants also reflected on some important points in regards to the content of the video that they found the most engaging for them.

Part 2. Comments made by the teachers about the usefulness of the intervention in their class were generally positive. The teachers reported that all four participants in the study had used the intervention again during the time it was made available in the learning space. Reece, Sarah, and Anna had all taken themselves to the area where the videos were available without being directed by a teacher or adult. Jake’s home base teacher commented that she would direct him there if she *“felt he needed some ‘calm down time’”*.

Teachers also commented that a number of children that were not participants in the study had also watched the videos. A teacher in Learning Space A reported the “*kids would take themselves there for some ‘calm down’ time*”. One teacher recalled that they directed a student there when he “*had a tanty*” (tantrum). The teachers’ comments suggested that they appreciated having a space for the children to use. One teacher in Learning Space B suggested this was important given the learning environment of collaborative classroom that caters for a large number of students. Reflecting upon the area where the videos were set up for use she commented that “*they need that sort of space where they can go to tune out and relax*”. Teachers recalled an improvement in the children’s behaviour after being in the space. For example, one teacher commented that the child was “*definitely calmer, which is what we wanted*”. Jake’s teacher reported another positive from the use of the video. She recalled that after she had directed Jake to the space to go and watch a video that he “*came back.....and did his activity.....so that’s a result from it*”. Overall, the teacher’s comments were positive in regards to having the use of the videos available in their learning spaces over the 10-day period.

Chapter 5

Discussion

This study explored the effects of a simulated nature-based intervention on the physiological and behavioural responses of children with post-traumatic stress symptoms. It used a single-subject design with repeated measures of heart rate and teacher-reported behaviours to explore this. The following research question was addressed in this study: is a simulated nature experience effective in reducing the physiological and behavioural responses of post-traumatic stress in children exposed to the Christchurch earthquakes? This research question will be explored in two parts. Firstly, the effectiveness of the nature videos on physiological responses will be explored using the heart rate results. Secondly, the effectiveness of the nature videos on the behavioural response will be explored using the results of the teacher-reported behaviour. These results will be contrasted with previous studies that have explored the effectiveness of nature-based interventions.

Heart Rate

The heart rate results do not indicate any overall effects that the nature videos could reduce the participants' physiological stress responses. Specifically, there was no consistent reduction in participant's heart rate between T1 and T2 across all days during the nature-video intervention phase. Likewise, participants' heart rate was not lower after they had watched a nature-video in comparison to their heart rate after they had watched a non-nature video. For some participants, their heart rate was at a similar level after they had their regular playtime as it was after they had watched the nature video. Overall, these results do not reflect the findings that would be anticipated given the rationale provided by the Stress Reduction Theory (SRT) that claims nature exposure is stress reducing (Ulrich, 1981; 1983).

While the nature videos did not show any overall effectiveness in reducing the participants' physiological stress responses, there were some results that showed promising potential. First, heart rate difference was below zero for over half of the sessions during the nature-video intervention for three of the participants (Sarah, Reece, and Anna). It is, therefore, possible that the intervention was able to reduce stress on some occasions. It is important to note that reductions in stress between T1 and T2 were not limited to the intervention phase alone as heart rate difference was below zero during at least one of the baseline phases for all participants. This proposes that the children's regular play and the non-nature movie, which occurred between T1 and T2 in the other phases were also stress reducing.

Only one previous study has used heart rate as a measure of stress to explore the effects of watching a nature video. That study found that watching a nature video is more effective in reducing heart rate, following a stressor, than watching a video of a non-natural environment (Ulrich, 1991). In the current study there was no distinction between the nature video and non-nature video results for heart rate difference. However as mentioned in the analysis in Chapter 2, it is important to consider that the difference reported in heart rate in the study by Ulrich (1991) may be due to the stress-inducing effects of a non-natural environment rather than the stress reducing effects of the natural environment. Furthermore, compared to the chronic stress symptoms of the participants in the current study, the participants in Ulrich (1991) had an induced stress which could be argued would reduce over time without any intervention.

Additional studies have used heart rate to measure the effectiveness of a nature-based experience other than watching a video. These studies have demonstrated diverse effectiveness. However, examining their effectiveness in relation to the intervention format

used to deliver the nature-based experience may provide explanations for the results seen in the current study.

Nature-based interventions that required adult participants to walk in a natural environment (Song et al., 2015), sit in a natural environment (Sonntag-Ostrom et al., 2014), or experience nature through virtual reality were more effective at reducing heart rate than nature-based interventions that involved participants listening to nature sounds (Largo-Wight, et al., 2016) or viewing pictures of nature (Gladwell et al., 2012). For this reason, it could be hypothesised that effective heart rate reduction requires actually being in the natural environment, or experiencing a realistic simulation of nature. The nature videos in the current study may not have been effective in creating a realistic simulation of nature. De Kort & Ijsselsteijn (2006) commented that the experience of realism is an important consideration when researchers are considering the potential restorative benefits of virtual environments.

Previous research with child participants reported that heart rate reduced after a nature-based activity when compared to an outdoor free play activity. This finding was not congruent with the results of the current study, which demonstrated that for only one participant (Anna) heart rate was at a lower at T2 during the nature-video phase in comparison to the baseline 1 phase, which involved outdoor play. Again, it is important to consider that the intervention in the study by Berto et al. (2015) may have been more effective as it involved a real nature experience as opposed to the simulated nature experience of the current study. Moreover, it is also important to recognise that the current study's nature intervention was significantly shorter than the 90-minute nature activity in the study by Berto et al. (2015).

In summary, while the nature-videos showed no overall effectiveness in reducing the physiological responses of the participants, there were some results that showed promising potential. Comparing the results of the current study to those in previous studies outlines that

the extent to which the simulated nature is a so-called real experience may be an important factor when it comes to reducing physiological stress. The duration of the nature-based intervention must also be considered given the brief intervention in the current study, and the length of the nature experiences in other studies that have found more effective results.

Teacher-Reported Behaviour

Similar to the heart rate results, the results from the teacher-reported behaviour results did not indicate any overall effects that the nature videos could reduce the participants' behavioural stress responses. Although all participants' score were low across the nature-video phase, these were generally low across all other phases as well. For two participants, Anna and Jake, it appeared their teacher-reported behaviours were improving anyway, prior to the introduction of the nature-video phase.

In relation to Attention Restoration Theory (ART) (Kaplan & Kaplan, 1995; 1995), it would be anticipated that the participants in the current study would have had a reduction in inattentive behaviours after watching a nature-based video as the theory suggests that nature provides relief from over worked directed attention. However, the additional analysis conducted on the item reflecting inattentive behaviour did not indicate that participants' attention or concentration had improved after they had watched a nature video, or that it was any better after watching the nature video in comparison to after their regular playtime or after watching a non-nature video.

There were, however, some promising findings from the teacher-reported behaviour results. All participants had at least one during the intervention where the teacher rated their behaviours as zero after watching the nature-based video. For three of the participants, a rating of zero was restricted to days during the intervention phase only. For Reece, however, there were days during the other experimental phases where teacher-reported behaviours were also zero. It is therefore is difficult to ascribe this improvement in teacher-reported

behaviours during the experimental phase to the intervention alone. Furthermore as outlined earlier, Jake and Anna's decreasing trend during baseline for these behaviours indicated that improvements seen during the intervention phase may not be accounted for by the nature-videos alone.

To date, only one study has explored the effects of a nature intervention on children's behaviour in a school environment (Swank et al., 2015). This study indicated that Nature-Based Child Centre Play Therapy (NCCCPT) was effective in reducing problem behaviours, as rated by an observer, for two of the four participants. Although the current study did not identify any convincing findings that stress related behaviours improved 30 minutes after viewing the video, there are some promising results in that there were days during the intervention phase where teachers rated behaviours as zero for all participants. It is also important to consider that the intervention in the study reported by Swank et al. (2015) was not purely a nature experience as Child-Centred Play Therapy (CCPT) involved the participants exploring and expressing themselves through play within a supportive relationship developed with a counsellor. There is evidence that regular CCPT is effective in reducing a number of childhood issues, including problem behaviours at school (Bratton & Ray, 2000) independent of any nature-based component.

As mentioned earlier, inattentive behaviours have also been identified as problem in children with trauma related stress symptoms and disorders (van den Heuvel & Seedat, 2013; American Psychological Association, 2013). Previous research has demonstrated that children with attention deficits performed better on a task that required concentration after walking through a natural environment in comparison to after walking through a non-natural environment (Faber Taylor, & Kuo, 2009). The results of the current study are not congruent with the results from Faber, Taylor, and Kuo (2009) in that the teacher ratings at T3 did not demonstrate any improvement in the participants' attention or concentration 30 minutes after

watching the nature video. Again, it is important to consider that the nature experience in the current study was dissimilar to the intervention in Faber, Taylor, and Kuo (2009) that was both longer, and involved interaction with real nature.

In summary, while the nature-videos showed no overall effectiveness in reducing the physiological responses of the participants, there were some results that showed promising potential. Similar to the heart rate findings, the extent to which the simulated nature is a so-called real experience may be an important factor when it comes to reducing behavioural stress responses. However, the current research exploring the possible effects of nature on children's behaviour is limited, which highlights the need for further studies.

Social Validity

Social validity results indicated a positive response towards the intervention from the participants in the study, and their comments reflected the anticipated effects of the videos – that they would be calming. Furthermore, comments made by the participants also provided important information regarding the content of the videos. Firstly, all participants noted that the videos were too long and boring. Secondly, two participants commented that they enjoyed watching the videos with animal content. Interestingly, heart rate difference results on the days in which participants watched videos with animal content (days six and seven) showed that heart rate decreased between T1 and T2 for all four participants on both days with one exception; Sarah's heart rate increased between T1 and T2 on day 7. This finding, in combination with comments made by participants, highlights an important consideration in relation to theories about the restorative benefits of nature. Attention Restoration Theory (ART) suggests that for natural environments to be beneficial to individuals, they need to hold enough interesting information to maintain the individual's indirect attention (Kaplan, 1995). For children, the addition of animal content in a nature-based intervention may increase self-

reported enjoyment, and possibly increase the likelihood that children would use nature-based interventions.

Following the class-wide use of the intervention, teachers commented on the acceptability and usefulness of the videos as a stress reducing aid for the students. Furthermore, the teachers identified that children were calmer after watching the videos, which was their intended purpose but there are limitations in ascribing these benefits to the nature videos alone. First, teachers commented that they appreciated there was a “*safe space*” for the children to use in the learning space. Secondly, the teachers reported that there was no way they could be sure that students were actually watching the videos while they were in the space where the intervention was set up. This limits the inferences that can be made between the children watching the video and the changes their behaviour as the benefits may have come from simply having a space that children felt safe or could be alone.

Overall, the participants’ and teachers’ comments were positive towards both the individual experience of the intervention and the learning space-wide use of the videos. It is also important to consider that participants were aware that the videos they watched were for the purpose of reducing stress because this was outlined in the information sheet, provided in the recruitment phase. Moreover, teachers were also aware that the videos were intended to reduce stress in children because this was also outlined in the information sheet provided to them, and was discussed by the researcher with the students in their learning space while the teachers were present. It is, therefore, important to consider that teachers and participants may have answered in socially desired ways (Krumpal, 2013). This is more so an important consideration given the researcher’s employment as a teacher at the school.

Limitations

This study has a number of limitations. These limitations include problems with the recruitment process and selection of participants, methodological issues, measures used in the study, and intervention fidelity.

The first limitation was the process used to recruit participants for the study. No stringent inclusion criteria were created to ensure that participants had high levels of stress related symptoms. Because of this, although the children who became participants did have parent and teacher reported stress related behaviours, these were not as high as ideally envisioned for the study. This low level of stress can be reflected by the participants' heart rate at T1, which was not significantly different from the median age for children their age all participants, except possibly Jake. Adult studies exploring the effects of nature-based interventions on stress have ensured that suitable participants are recruited by requiring a diagnosis of a stress related disorder such as PTSD (Kotozaki, 2013; Vella et al., 2013) or exhaustion disorder (Sonntag-Ostrom et al., 2014). Other studies have ensured participants are stressed by subjecting the participants to a stressful task, and monitoring heart rate to ensure the desired effect of the task actually took place (Annerstedt et al., 2013). One study used blood pressure levels as a screening measure to ensure high levels of stress (Song et al., 2015). In child studies, a criteria of ADHD was required by one study (Faber Taylor, & Kuo, 2009) but not for the study by Swank et al. (2015). Overall, the consequence of non-stringent selection criteria in the current study resulted in the recruitment of participants without high levels of stress. As a result, the anticipated effects of the intervention may not have occurred, because the participants may not have been highly stressed before watching the videos. Given the previous research, it appears that nature-based interventions are most effective when participants are experiencing high levels of stress either as a result of a stressor or stress related disorder.

Another limitation in relation to the recruitment process was that parents provided information regarding the participants stress related symptoms. Although it was thought that parents may be better at reporting their child's stress related behaviours because they involved certain somatic symptoms likely only known to parents (i.e. troubles with sleep, bedwetting, nightmares) it has been found that there is inconsistency between parent and teacher reports of overall problem behaviours (Grietens et al., 2004). Although the teachers played a role in selecting suitable participants, the relatively low level of problem behaviours for all participants across the study may indicate that these behaviours are more of an issue in the home environment. Because of this, it may have been beneficial for the teachers to provide the screening information in order to acquire participants with higher levels of problem behaviours than the children in the current study.

There were a number of methodological limitations in the current study. A primary limitation was the phase lengths, in particular the number of days during baseline. The current study could not allow for a stable baseline to be established before implementing the intervention because delays caused by recruitment issues resulted in a limited number of days for all experimental phases to occur. As a consequence, the baseline data did not provide a stable representation of the participants' stress related measures that allowed the effectiveness of the intervention to be compared to. In addition, both Jake and Anna's teacher-reported behaviours at T3 showed a decelerating trend during baseline, which limits the conclusions that can be made about the effectiveness of the intervention on these behaviours.

A number of methodological limitations were the result of unavoidable circumstances that come with organising a study in a school environment. Firstly, there were a number of days that the study could not take place because teachers were away on school excursions, or participants were absent from school, or absent from class. As a consequence, there were gaps between days both within and between the experimental phases. Secondly, as a result of

limited room availability in Learning Space A, Reece and Sarah were required to watch the videos in the same room. These children may have been distracted by the presence of the other participant, which may have interfered with their engagement in watching the video. Possible lack of engagement in the intervention due to this distraction may have compromised their ability to fully obtain the hypothesised stress reducing effects of the nature video, which in turn may have affected the results. Thirdly, before T1 heart rate was obtained during the study participants were required to eat. Food intake has been shown to reduce heart rate by decreasing HPA activity (Adam & Epel, 2007) and increasing PNS activity (Browning & Travagli, 2014). Therefore, having a reduced heart rate before watching the video may have influenced the potential stress reducing effects that may have been more apparent should participants had not eaten beforehand. Finally, anecdotal comments were made by teachers to the researcher, regarding the difficulty they had observing the behaviour of the participants over the 30 minute time period due to distractions by other children. Because of this, results of the teacher rating of behaviour may not be an accurate representation of the participants' behaviour, and may have compromised the results.

Other limitations of the current study relate to the measures used to assess participants' stress. Firstly, while its relationship with ANS activation supports its use as a measure of stress (Taelman et al., 2009), heart rate is influenced by a number of environmental and individual factors. Sonntag-Ostrom et al. (2014) recognised that environmental factors such as noise, air quality, and temperature may have influenced the heart rate measures in their study. Although the current study was conducted in an indoor location, similar limitations can be highlighted because there was not any control over the temperature and noise levels of the rooms where the participants watched the video. As such, heart rate results may have been compromised by variables other than the participants' levels of stress. Secondly, the heart rate measurement used in the current study may not have

accurately captured the stress reducing effects that occurred from watching the video. Most notably, participants' heart rate was taken after they had watched the video, which overlooks any possible effects that may have occurred *while* the participants were watching the video. A more thorough understanding about the effects of the interventions may have been acquired by the use of continuous measurement of heart rate to explore the changes in stress levels may occur during the intervention (Bowler et al., 2010).

Another limitation of the measures used in this study was the use of a teacher report to gather data in relation to the participants' behaviour. Firstly, compared to an independent observer such as that used in the study by Swank et al. (2015), the current study did not have formal, reliable observation of the participants' behaviour between T2 and T3. Instead, it relied on the teacher's rating of the participants' behaviour, which has been argued is subject to relational bias (Ladd & Profilet, 1996). Secondly, the wording of the items made it difficult for the teachers to rate the child's behaviour quickly. This meant a delay between the teacher's observation and rating of the child's behaviour. Thirdly, the items on the scale were limited to only 10 descriptions of behaviour and these may not have been applicable to the behaviours of the participants. Overall, the limitations of the teacher rating scale may have resulted in an inaccurate representation of the participants' behaviour as the teacher reports may have been both biased towards the usual behaviour of the child, and inaccurate due to delays in completing the form. In addition, the limited range of behaviours for the teacher to rate the child on negate possible changes that may have occurred as a result of the intervention, as the behaviours might not have been captured on the scale's items.

This study also had limitations related to the fidelity of the intervention implementation. Because the researcher did not remain in the room with the participants it is unable to be confirmed that the participants were watching the video. Wolery (2011) argues that to reduce the infidelity of findings it is important to document any difference in the

implementation of the intervention that is different from the intended method. This may have been done in the current study by observing and noting the behaviours of the participants when they were required to watch the nature videos. As such, the use of a fidelity measure in the current study may have strengthened any inferences made between watching the video and the reduction the participants' stress. Conversely, intervention infidelity (i.e. days where participants were not apparently watching the videos) may have provided possible explanatory information in regards to results that did not match the study's hypothesis. Wolery (2011) also describes the importance of children's experience of the intervention that can be obtained through fidelity measures. In the current study it may have been useful to record which sessions the participants watched the videos as intended to help identify videos that are more likely to promote further use of the nature videos.

A final limitation of the current study is related to recent research that has shown that the blue light emitted from devices can affect cardiac ANS functioning (Nose et al., 2017). This study's results pose the possibility that the blue light from the devices used to watch the nature videos in the current study may have inadvertently increased SNS activity and increased the arousal levels of participants, thereby possibly affecting the heart rate results on some occasions. Furthermore, another recent study has shown that participants who performed tasks on a regular LED computer screen had reduced mood and performed slower on a cognitive task than participants who performed the same tasks with a blue light filter over the screen (Bansal, Prakash, Randhawa, & Kalra, 2017). These considerations need to be taken into account when considering the use of technology to create a nature-based experience.

Overall, a number of limitations may have prevented this study obtaining results that demonstrated the effectiveness of the nature-videos stress reducing benefits. These limitations included problems with the participant selection process, issues that arose as a

consequence of having a school-based study, and concerns with the measures used to evaluate the participants' changes in stress. Problems with the intervention fidelity were also raised, as were the potential confounding effects of delivering a simulated nature experience through a tablet computer device. These issues may have affected the results by preventing the potential effectiveness of the intervention, or by ineffectively capturing the actual changes in participants' stress as a result of watching the nature movie. Such issues are common in a first research project, but addressing them provides important information for any future studies.

Strengths

Despite the many limitations, the current study is a pioneer in its exploration of the effectiveness nature-based interventions in two different populations. Firstly, there is no known study that has explored the use of a simulated nature-based experience in a child population. Currently, a school-wide project called *Calm Learning Space* is being implemented by the Erikson Institute and a feature of this project is the use of nature-based videos that children can self-select to use as a type of reset activity while in the learning space (Schroedner, 2015). But, no published research relating to the project could be found. Secondly, most previous research has explored the effectiveness of actual nature experience on individuals with stress related disorders. Although simulated experience have proven to be effective in the treatment anxiety and specific phobias through exposure therapy (Parsons & Rizzo, 2008), this study marks the first to explore the use of a simulated nature-based intervention for individuals with a stress related symptoms.

Implications

Implications for research. The current study provides a foundation for future research to be conducted in the area of nature-based interventions. Although overall stress reducing effects of the videos were not found, there are some promising results from both

heart rate and teacher-rated behaviour that may warrant future investigation. Future studies may produce more significant results if the limitations of the current study are addressed. Recommended changes include recruitment of participants that have significant levels of stress, which may be assessed through a more thorough selection criteria than that used in the current study. Moreover, a number of studies have demonstrated that nature-based experiences are more effective when participants are presented with a stressor prior to the intervention. Although it is likely to be regarded as unethical to induce stress in a child, future studies may wish to monitor participants' stress levels over the day through the use of a heart rate device worn on the body. Participants could be directed to using the nature-based intervention in the event they become distressed, and data provided by the heart rate monitor could provide information about the physiological changes in stress that occur from watching the video. Moreover, issues highlighted regarding the validity of heart rate as a measure of stress suggest that other methods could be explored for future studies. Future studies may also be strengthened by use of formal observations to measure participants' stress related behaviours, and ensuring treatment fidelity by observing the participants while they watched the video. In addition, studies that use a simulated nature experience should acknowledge the recommendations made by de Kort and Ijsselstein (2006) and previous research that has demonstrated the importance of realism when creating electronically mediated environments. Furthermore, electronic devices used to deliver the simulated nature experience should have a filter to mitigate any potential physiological effects of the blue light that is emitted.

Implications for practice. The intervention used in the current study may provide teachers and learning spaces with an effective tool that can be used for stress management for students. Research has highlighted that teachers in Christchurch are working with a complex range of emotional and behavioural needs (Liberty et al., 2015), and that high levels of psychological burnout in Christchurch teachers is related to managing children's emotional

distress (Kuntz, 2014). Research has outlined that there are many different options for schools to adopt when working with children who are experiencing posttrauma stress (Pfefferbaum, Newman and Nitiema, 2016). The intervention in the current study was well received by teachers and students alike in the participating school, and could be a learning space aide that assists children to manage their stress. It is possible that the stress reducing benefits of nature acquired through a simulated experience may provide a pragmatically appealing substitute in places, such as schools, given the barriers educators have outlined that may impede the use of natural environments (Ernst, 2014).

Conclusions

This study explored the effectiveness of a simulated nature-based intervention on the reduction of physiological and behavioural symptoms of stress among children exposed to the Christchurch earthquakes. The results of the study did not support the hypotheses, in that there were no discernable changes in the participants' heart rate difference data or teacher rating of the child's behaviour either during the intervention phase, or between the nature video phase and the two baseline phases. Despite this, anecdotal reports from the participants and the teachers indicated that the intervention was understood as a way to reduce stress, which was its intended purpose. A number of limitations were addressed that indicate methodological changes in any future research. Overall, study provided further insight into an under researched area, and established a basis for further research into the exploration of the stress reducing effects that natural environments may afford.

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Appendix A: UCERHEC Approval Letter



HUMAN ETHICS COMMITTEE

Secretary, Rebecca Robinson
 Telephone: +64 03 364 2987, Extn 45588
 Email: human-ethics@canterbury.ac.nz

Ref: 2016/47/ERHEC

14 September 2016

Clare Vesty
 School of Health Sciences
 UNIVERSITY OF CANTERBURY

Dear Clare

Thank you for providing the revised documents in support of your application to the Educational Research Human Ethics Committee. I am very pleased to inform you that your research proposal “The Effects of a Simulated Nature Experience on Physiological and Behavioural Responses of Young Children with Post-Traumatic Stress Symptoms” has been granted ethical approval.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 9th September 2016.

Should circumstances relevant to this current application change you are required to reapply for ethical approval.

If you have any questions regarding this approval, please let me know.

We wish you well for your research.

Yours sincerely

PP

R. Robinson

Patrick Shepherd
Chair
Educational Research Human Ethics Committee

Please note that ethical approval relates only to the ethical elements of the relationship between the researcher, research participants and other stakeholders. The granting of approval by the Educational Research Human Ethics Committee should not be interpreted as comment on the methodology, legality, value or any other matters relating to this research.

F E S

Teachers

Clare Vesty

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The effects of a simulated nature experience on physiological and behavioural responses of young children with stress symptoms.

Information Sheet for Principal, Board of Trustees and Teachers

My name is Clare Vesty and I am a studying towards a Masters of Science in Child and Family Psychology at the University of Canterbury. I am currently completing the thesis component of my degree where I am interested in exploring the effectiveness a programme designed to reduce physiological and behavioural symptoms of stress in young children. My senior supervisor, Associate Professor Kathleen Liberty, has recently published an article highlighting an increase in symptoms of stress in primary aged children following the Christchurch Earthquakes.

This is a study based on research with adults that has shown that viewing certain images like those in travel brochures or cartoons can reduce symptoms of stress. I am interested in finding out if the same applies for children. I don't want to detail what the images are, because the teacher and children might want to view the images first, and that would make it impossible for me to do the research!

I would like to invite seven and eight year old students, and their teachers, to participate in the study. With your help, I would like to select teachers who are interested in my research and their class to take part. Please note while participants will only be recruited from this one class, any teacher working with the participating class in a collaborative environment must also consent to take part as they may be required to provide behavioural observations of the participating children at some point. Furthermore, should not enough participants be recruited from the initial class, I will open participation to the class of the collaborative teaching partner. I will offer the programme to any teacher who would like to provide it to their class, but are not selected to take part in the study. I can provide them with the resources necessary to use it in their teaching space.

Following consent from the Principal, Board of Trustees and teachers, the following will be involved:

1. The teacher of the selected class will send home to 7 and 8 year old students: a parent/caregiver and child information sheet, a parent/caregiver consent form, a child assent form, child demographic information form, and two questionnaires to be completed by a parent/caregiver. Those willing to take part will return their completed consent forms and questionnaires in a sealed envelope (provided) to the office where I ask that they are please stored in a secure location (i.e. locked drawer) from where I will collect them. A week will be given for parents/caregivers/children to return these.

2. For the first part of the study, four children will be selected from those for whom parent consent is obtained. Selection of the four participants will be based on information provided in the questionnaires that will highlight which individuals would benefit the most from the programme's potential stress reducing benefits. Children who do not participate in the first part of the study will be invited to take part in the second part of the study (when the programme is made available to the class as a whole). I will let the parents know which part of the study their child will be in.
3. The four children participating in Part one will meet me in a quiet space available in the school, such as the library, during either their morning tea or lunch, after they have eaten. During this time they will watch a video with headphones on for ten minutes. This will be completed before class time resumes after their break. They will be asked to do this for 12 days. The child is able to choose not to watch the video. NB: all videos watched will be child friendly (e.g., travel movies; cartoons) and are designed to reduce stress or be interesting for the participants.
3. The children who participate will have their heart rate measured using an oximeter, which is a device that attaches to the end of the participant's fingertip. This will be measured before and after they watch the videos, as well as before and after their regular playtime activities for four days before and four days after the programme. If the child does not want their heart rate measured, they will be able to refuse and return to their regular activities. If a child refuses for three consecutive days, they will be able to terminate participation. Another child will be elected to participate in the study.
4. The teacher will complete a 10-item behaviour rating scale to provide information about the participating child's behaviour 30 minutes after either the child's morning break or first lunch break. This will be completed once a day for a total of 20 days. The form should take no longer than two minutes to complete each time.
4. Following the programme, I will conduct a short audio-recorded interview with the participating children. I will do this at an appropriate time, discussed with the child's teacher. This will gather information about the child's feelings towards the programme.
5. If the programme is well received by the participating children, and initial results indicate its effectiveness, I would like to offer the chance for the programme to be available to all students in the class for a 10-day period, if the classroom teacher agrees. This would involve setting up a small space in the classroom. This space will include a beanbag, headphones, and a device in which the students can access the video programme. The children in the classroom could then opt to take themselves if they are feeling stressed. The children will self-nominate for this, and they will not have to describe their feelings. If the teacher agrees, he/she will be asked to complete a short interview about the use of the programme in their classroom following the 10-day period. This should take no longer than 10 minutes to complete.

Please note that participation in the study is voluntary, and the school, staff, students and their parents have the right to withdraw at any stage without penalty. If anyone wishes to

withdraw, I will do my best to remove any information relating to the participants, provided this is practically achievable.

All information gathered will remain confidential and kept in locked storage facilities at the University of Canterbury, or on a password protected computer. It will only be accessed by my two supervisors, Kathleen Liberty and Lawrence Walker, and myself. The children in the study will be assigned code names to ensure their confidentiality. Any publication of the research will not contain any information that would permit the identification of any students, parents, teachers or the school. My completed thesis is a public document, which can be accessed via the UC library database. All information/data gathered will be held in secure storage for five years after which it will be destroyed.

Upon completion of my study, a copy of a report on the findings will be provided to the school.

If you have any questions or concerns about the study, you can contact me (details above), or my supervisors Kathleen Liberty (telephone: (03) 364 2545 email: kathleen.liberty@canterbury.ac.nz) and Lawrence Walker (telephone: 0800 021 328; email: lawrence.walker@canterbury.ac.nz).

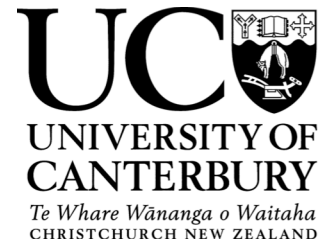
There are no known risks for participating in this research. My research study has received ethics approval from the University of Canterbury Educational Research Human Ethics Committee. If you have a complaint, you may contact The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If there is agreement to participate in this study, I ask that the Principal, a representative of the Board of Trustees, and the participating teacher and collaborative teaching partner (if applicable) sign the appropriate consent form provided. Once completed, signed if consenting or unsigned if not consenting, please return to the Principal who will contact me to collect.

Thank you for considering your school's participation in the study.

Clare Vesty

Clare Vesty
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The effects of a simulated nature experience on physiological and behavioural responses of young children with stress symptoms.

Information Sheet for Parents

My name is Clare Vesty and I work on a casual basis as a teacher at XXX School. I am also currently completing a Masters of Science in Child and Family Psychology at the University of Canterbury. As part of my degree I am completing a thesis, which is a research project that I am completing under the supervision of Associate Professor Dr Kathleen Liberty and Mr Lawrence Walker.

I am interested in exploring the effectiveness of a programme that aims to reduce both physiological and behavioural symptoms of stress in children. My senior supervisor, Associate Professor Kathleen Liberty, has recently published an article highlighting an increase in symptoms of stress in primary aged children following the Christchurch Earthquakes. Your child's teacher, and the school's Principal and Board of Trustees have agreed to take part in the study. I am inviting all students in your child's class to take part. Please note that **participation is voluntary**. Should you and your child wish to take part, the following will be required from you and/or your child:

- Read through together with your child the information on the 'Child Information Sheet', and talk about this with your child. If your child understands what will be required should they take part, please help them to read through and sign the 'Child Assent Form'.
- Parent/caregiver complete the 'Parent Consent Form', and the form/questionnaire booklet provided. **Skip any questions that you don't want to answer.** It should take no longer than 10 minutes to complete all the questionnaires.
- Return the parent consent form, child consent form, and completed questionnaires to the school office in the sealed envelope provided. Please aim to return these by **Wednesday 22nd February**. They will be stored in a secure space until I pick them up from here.

Please note that due to time and resource constraints, only four children will be selected to take part in the first part of the study. Selection of the four participants will be based on information provided in the questionnaires that will highlight which individuals would benefit the most from the programme's potential stress reducing benefits. However, all students in your child's class may be provided with access to the programme in the second part of the study, if the programme looks to be effective and the teacher approves. I will contact all parents who both themselves and their child consent to take part to inform you if

your child will/will not take part. If your child **is** one of the four participants selected however, the following will be asked of you and your child.

- Your child will meet me during either their morning tea playtime **or** their first lunch playtime (after they have eaten) in a space provided by the school (i.e. the classroom or library). I will let your child and their teacher know what time they will be required. Another classmate taking part in this study may also be present at the same time. During this time they will watch a **10-minute** child-friendly video. This video will be similar to a travel video or cartoons, and selected to reduce stress and/or be of interest to your child. They will do this for a total of 12 times. They will return to class in time for their classroom learning activities.
- Your child will be asked to have their heart rate measured using an oximeter, which is a device that clips onto their finger. I will be using to it to gather information about your child's changes in heart rate. This will be measured each day of the study. Your child can refuse at any time to have their heart rate taken.
- Your child's teacher will provide information about your child's classroom behaviour following either their morning tea or first lunch break every day of the study.
- After the study I will provide you with another copy of the Health and Behaviour Questionnaire to complete. This has 15-items on it that should take you no longer than five minutes to complete. Another sealed envelope will be provided for you to return this to the office where I will collect it.
- After the study I will conduct an interview with your child to gather some information regarding their feelings and opinions around the programme. This will be audio recorded to ensure accurate information is gathered from the interview. It will take approximately 10-minutes and will be conducted at a suitable time arranged with your child's teacher.

Please note that your participation and your child's participation in this study is voluntary. You and your child can withdraw at any stage without penalty. If you choose to withdraw, I will do my best to remove any information relating to you and your child, provided this is practically achievable. Your child is able to refuse to watch the video or have their heart rate measured on any day.

Please note that other children in your child's class or school may be aware that they are taking part in the study as they may be seen going to meet me during their break time. However, I will take particular care to ensure the confidentiality of the information/data gathered from you and your child. It will be only accessed by my two supervisors, Kathleen Liberty and Lawrence Walker, and myself. Your child will be assigned a code name to ensure the confidentiality of the information/data I gather about them. I will also take care to ensure anonymity in any publications of the findings. You, your child, your child's teacher or the school will not be able to be identified in any publication of the study. My completed thesis is a public document, which can be accessed via the UC library database. All information/data

will be securely stored in password-protected facilities and locked storage at the University of Canterbury for five years following the study. After this time, all information will then be destroyed.

The school will be provided a report of the findings from this study after I complete my thesis – this will be early next year. This report will also be provided to you: please leave either an email or postal address in the space provided on the ‘Parent Consent Form’.

If you have any questions or concerns about the study, you can contact me (details above), or my supervisors Kathleen Liberty (telephone: (03) 364 2545 email: kathleen.liberty@canterbury.ac.nz) and Lawrence Walker (telephone: 0800 012 328; email: lawrence.walker@canterbury.ac.nz).

There are no known risks for participating in this research. My research study has received ethics approval from the University of Canterbury Educational Research Human Ethics Committee. If you have a complaint, you may contact The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

Should you and your child understand the requirements of the study and consent to taking part, please complete the ‘Child Assent Form’, the ‘Parent Consent Form’ and the questionnaire booklet. Once completed, please return these to the school office where they will be kept in a secure place until I collect them. I will then contact you with further information about your child’s involvement.

Thank you for considering participation in the study.

Clare Vesty

Clare Vesty
Telephone: 022 309 3223
Email: clare.vesty@pg.canterbury.ac.nz



The effects of a simulated nature experience on physiological and behavioural responses of young children with stress symptoms.

(Please read to your child: Are children less stressed and have more positive behaviours after watching a nature video?)

Information Sheet for Child

(Please read this to your child and talk about it with them)

As well as being a teacher, Miss Vesty goes to university where she is learning about children and their families. She has to do a project at university as part of her degree. She has decided to find out if children can feel more relaxed and have more positive behaviours after watching a nature video. She has asked all the students in your class if they would like to take part. After I read this to you, you can choose if you would like to take part or not.

Here's what will happen if you want to take part. First of all I will complete a questionnaire that will give Miss Vesty some information about you. This will get left at the school office in a safe place until Miss Vesty picks it up. She will then choose four children to take part in the study. If you don't get to take part in the first part of her study, you may still get to participate the second part as she may let everyone in your class have a chance to watch the videos that are part of the programme in her study.

*If you **do** take part in the first part of her study the following will happen:*

- *You will meet Miss Vesty in a classroom or the library during one of your playtimes. Another one of your classmates might be with you at the same time because they are also taking part in the study.*
- *You will sit in a beanbag or a chair and watch a video on a tablet. Miss Vesty will give you a set of headphones so you can listen to the sound. The videos will go for five minutes. You will do this for 12 days.*
- *Miss Vesty will measure your heart rate using an oximeter (have a look at the picture!), which clips onto your finger. You might feel a bit of pressure on your finger when it is on, but it won't pinch or hurt you. She will measure your heart rate before and after you watch the videos, and also some days before and after you go out to play.*
- *Your teacher will also fill out a form about your classroom behaviour to help Miss Vesty work out if the videos might help children have more positive behaviour.*
- *Miss Vesty will ask you some questions about the video and will record and take notes about your answers so she can remember what you said. She can show you what she has written down at the end.*
- *Your whole class might get the chance to watch the videos at some point on the tablet. This will only happen if Miss Vesty's study is showing they are helping the children in her study. Miss Vesty will give you and your class more information about this if it happens.*

Here are some important things you should know:

- *If you participate you will miss some of your playtime at **one** of your breaks for 12 days.*
- *Other children might know you are in the study because they might see you going to meet Miss Vesty.*
- *You can choose not to go and watch the videos during your break time if you don't want to. Even if you say "yes" now and decided at the time you don't want to, that's ok. You can tell Miss Vesty you don't want to, even though she is a teacher! If you don't want to tell her, tell your teacher who will let Miss Vesty know.*
- *You can say 'no' to having your heart rate measured with the oximeter at any time.*
- *If you take part Miss Vesty's study, you will be given a code name so that no one reading her project will know your real name. Your information will be kept private so that the only people who will see it will be Miss Vesty and her teachers at university.*
- *Other people will be able to read Miss Vesty's project on the computer, but they will not know that you, your parent/caregiver, teacher or your school were in it.*
- *All of your information that Miss Vesty collects about you will be kept in a safe place at her university, and be destroyed after five years so that no one can see it. When the study is finished, Miss Vesty will give a copy of the results to your school, and one to your parents that they can read through with you.*

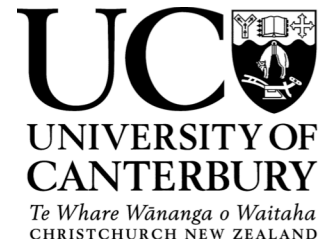
If you have any questions or concerns about the study, you can contact Miss Vesty (details above), or her teachers Kathleen Liberty (telephone: (03) 364 2545 email: kathleen.liberty@canterbury.ac.nz) and Lawrence Walker (telephone: 0800 021 328; email: lawrence.walker@canterbury.ac.nz) or the person in charge The Chair, University of Canterbury Human Ethics Committee; (human-ethics@canterbury.ac.nz). If you change your mind about being in the study, that is okay. Just tell your teacher, Miss Vesty or me.

Miss Vesty



Oximeter used to measure heart rate

Clare Vesty
Telephone: 022 309 3223
Email: clare.vesty@pg.canterbury.ac.nz



The effects of a simulated nature experience on physiological and behavioural responses of young children with stress symptoms.

Consent Form for Principal

I have been given a full explanation of the project and have been given the opportunity to ask questions.

I understand the requirements for my school to take part in the study.

I understand that participation is voluntary, and that I may choose to withdraw my school at any stage without penalty.

I understand that any published or reported results will not identify any student, teacher, or the school.

I understand that all information gathered for the study will be kept in locked and secure facilities at the University of Canterbury and/or password protected electronic form and will be destroyed after five years.

I understand that a copy of a report of the findings will be provided to the school upon completion.

I understand I require further information regarding the study we can contact the researcher, Clare, or one of her supervisors for further information.

I understand that if I have any complaints that I can contact The Chair, University of Canterbury Educational Research Human Ethics Committee.

By signing below, I agree to participate in this research project. (Do not sign if you do not consent).

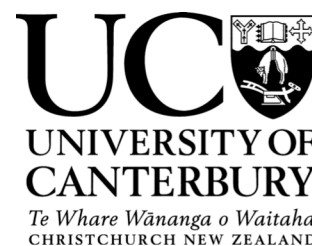
Name of Principal (please print)_____

Name of School:_____

Signature:_____

Date:_____

Clare Vesty
Telephone: 022 309 3223
Email: clare.vesty@pg.canterbury.ac.nz



The effects of a simulated nature experience on physiological and behavioural responses of young children with stress symptoms.

Consent Form for Board of Trustees

We have been given a full explanation of the project and have been given the opportunity to ask questions.

We understand the requirements of the school should we agree to take part in the study.

We understand that participation is voluntary, and that we may elect to withdraw the school and the participants from the study at any stage without penalty.

We understand that any published or reported results will not identify any student, teacher, or the school.

We understand that all information gathered for the study will be kept in locked and secure facilities at the University of Canterbury and/or password protected electronic form, and will be destroyed after five years.

We understand that a copy of a report of the findings will be provided to the school upon completion.

We understand that if we, collectively or individually, require further information regarding the study we can contact the researcher, Clare, or her supervisors Kathleen Liberty (telephone: email: kathleen.liberty@canterbury.ac.nz Telephone (03) 3642987 ext 6545) or Lawrence Walker (telephone: 0800 021 328; email: lawrence.walker@canterbury.ac.nz).

We understand that if any of us has a complaint that we can contact The Chair, University of Canterbury Educational Research Human Ethics Committee.

By the representation of the chairperson's signature, we agree to the school's participation in this research project.

Chairperson: Board of Trustees (please print name): _____

Signature: _____

Date: _____

Clare Vesty
Telephone: 022 309 3223
Email: clare.vesty@pg.canterbury.ac.nz



The effects of a simulated nature experience on physiological and behavioural responses of young children with stress symptoms.

Consent Form for Teachers

I/We have been given a full explanation of the project and have been given the opportunity to ask questions.

I/We understand my/our requirements should I/we agree to take part in the study.

I/We understand that participation is voluntary, and that I/We may choose to withdraw at any stage without penalty.

I/We understand that any information or opinions we provide will be kept confidential by the researcher and her supervisors, and that any published or reported results will not identify any student, teacher, or the school.

I/We understand that all information gathered for the study will be kept in locked and secure facilities at the University of Canterbury and/or password protected electronic form and will be destroyed after five years.

I/We understand that a copy of a report of the findings will be provided to the school upon completion.

I/We understand that if we, collectively or individually, require further information regarding the study we can contact the researcher, Clare, or one of her supervisors for further information.

I/We understand that if any of us have a complaint that we can contact The Chair, University of Canterbury Educational Research Human Ethics Committee.

By signing below, I/we agree to participate in this research project. (Do not sign if you do not consent).

1. Participant Teacher's Name (please print): _____
 Signature: _____ Date: _____

2. Collaborative Teacher's Name (please print): _____
 Signature: _____ Date: _____

Clare Vesty
Telephone: 022 309 3223
Email: clare.vesty@pg.canterbury.ac.nz



The effects of a simulated nature experience on physiological and behavioural responses of young children with stress symptoms.

Consent form for Parent/Caregiver

I have been given a full explanation of this project and have been given the opportunity to ask questions and have them answered.

I understand what is required if my child and I agree to take part in this study.

I understand that only four children will be chosen to take part in the study and that my child not be selected. I understand that the programme used in the study may be available for my child at a later time if they do miss out on being a participant.

I understand that participation is voluntary and that I may withdraw myself or my child at any stage without penalty.

I understand that any information or opinion I provide will be kept confidential to the researcher and her supervisors, and that any published information or reported results will not identify me, my child, or my child's teacher and school.

I understand that all data collected for the study will be kept in locked and secure facilities at the University of Canterbury and/or password protected electronic form and will be destroyed after five years.

I understand there are no identified risks in undertaking the study.

I understand that the school will receive a copy of the report on the project's findings, and that I will be sent a copy of these too.

I understand that if I require further information, I can contact Clare, or her supervisors by phone or email using the details provided on the information sheet.

I understand that I can contact The Chair, University of Canterbury Educational Research Human Ethics Committee, if I have any complaints.

By signing below, I agree to participate in this research project.

Name _____

Signature _____

Date _____

Email/Postal Address (for copy of findings) _____

Appendix I: Child Assent Form

Miss Vesty
 Telephone: 022 309 3223
 Email: clare.vesty@pg.canterbury.ac.nz



**The effects of a simulated nature experience on physiological and behavioural responses of young children with stress symptoms.
 (Are children less stressed and better behaved after watching a nature video?)**

Assent Form for Child

Miss Vesty/Mum/Dad/Caregiver has told me about the study and I understand what I need to do. I have been given a chance to ask questions about it and have Miss Vesty/Mum/Dad/Caregiver answer them.

I understand that Miss Vesty will only have four children in her study, which means that I may not be one of them even if I return my forms. I do understand that I may still have the opportunity to watch the videos from the programme at some point, as Miss Vesty will give it to my whole class to use.

I understand that if I am part of the study, I will meet Miss Vesty somewhere (i.e. the library) during one of my break times where I will watch a video. I understand that I will do this for 12 days.

I understand that if I am part of the study, Miss Vesty will take my heart rate by clipping a device on the end of my finger. I understand that she will do this before and after I watch the videos as well as before and after some of my playtimes. I understand that the teacher will fill in forms about my behaviour.

I understand that children in my school or class might know I am part of the study because they might see me going to meet Miss Vesty during my break time.

I understand that if I am part of the study, Miss Vesty will talk to me about the videos at the end of the study and I am okay for her to record it so she remembers what we talked about.

I understand that I don't have to take part in the study, and that I can stop being involved at any time without anyone getting angry or upset, and that I won't get into trouble. I just need to tell Miss Vesty/my Teacher/Mum/Dad/Caregiver.

I understand that Miss Vesty may write or talk about the study but no one will know that it was me who took part because another name will be used instead of my real name. I understand that other people, like Miss Vesty's teachers at university, may be allowed to read it and that people can read it on the computer, but they won't know it was me who took part.

I understand that all data/information Miss Vesty collects about me will be kept in a safe place at her university where it is locked away so that others cannot see it. If the data/information is on the computer, people won't be able to see it because there will be a password stopping them from seeing it. I understand that all the data/information will be destroyed after five years.

I understand I am not at risk of getting hurt by participating in the study.

I understand that my school will receive a copy of the results from this project, and that Mum/Dad/Caregiver will receive one too which they can talk through with me.

I understand that I can get more information about the study from Miss Vesty (her phone number and email are at the top of the letter) or her teachers at university Kathleen Liberty (email: kathleen.liberty@canterbury.ac.nz; telephone (03) 3642987 ext 6545) or Lawrence Walker (email: lawrence.walker@canterbury.ac.nz; telephone: 0800 021 328).

I understand that I can contact The Chair, University of Canterbury Educational Research Human Ethics Committee (human-ethics@canterbury.ac.nz), if I have any concerns about the study.

I understand that if I write my name below, I am agreeing to take part in Miss Vesty's study.

Full name_____

Primary Caregiver's Name_____

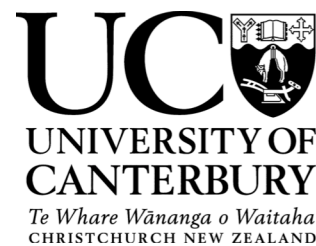
Signature _____

Date_____

Thank you.

Appendix J: Demographic Information Form

Clare Vesty
Telephone: 022 309 3223
Email: clare.vesty@pg.canterbury.ac.nz

**Demographic Information Form**

Please give details of your child's:

Name: _____

Date of birth: _____

Gender: _____

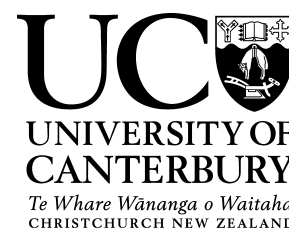
Ethnicity: _____

Parent/caregiver's name: _____

Contact number: _____

Clare Vesty

Telephone: 022 309 3223

Email: clare.vesty@pg.canterbury.ac.nz

Name: _____

Health and Behaviour Questionnaire

1. In the last 12 months, has your child had any of the following? Please circle your answer.

a. Trouble going to sleep?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
b. Nightmares?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
c. Fear of sleeping alone?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
d. Waking in the middle of the night?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
e. Changes in their eating or eating problems?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
f. Headaches?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
g. Stomach aches?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
h. Wet or soiled the bed?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
i. Anger outbursts?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
j. Concentration problems or difficulty paying attention?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
k. Is high strung, tense and nervous?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
l. Is easily confused, seems to be in a fog?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
m. Is impulsive or acts without thinking?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
n. Is restless, overly active, cannot sit still?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
o. Has a strong temper and loses it easily?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
p. Is withdrawn, does not get involved with others?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
q. Clings to adults?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
r. Cries too much?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
s. Demands a lot of attention?	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>
t. Is too dependent on others	<i>no</i>	<i>yes</i>	➔ in the past week?	<i>no</i>	<i>yes</i>

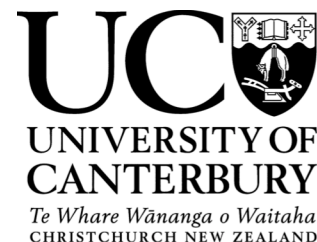
Appendix L: Christchurch Earthquake Questionnaire

Clare Vesty

Telephone: 022 309 3223

Email: clare.vesty@pg.canterbury.ac.nz

Name: _____



Christchurch Earthquake Questionnaire

Please circle the words yes, no, or ? below to indicate where your child was at the time of the major earthquakes in Christchurch.

<i>Date</i>	<i>Day and Time</i>	<i>In Christchurch or Canterbury</i>	<i>With Parent</i>	<i>At Preschool</i>	<i>Unsure</i>
4 September 2010	Saturday 4:20am night time	yes no	yes no	yes no	?
22 February 2011	Tuesday 12:51pm early afternoon	yes no	yes no	yes no	?
13 June 2011	Monday 2:20pm mid-afternoon	yes no	yes no	yes no	?
23 December 2011	Friday 3:18pm mid-afternoon	yes no	yes no	yes no	?
14 February 2016	Sunday 1:13pm early afternoon	yes no	yes no	yes no	?

Clare Vesty
Telephone: 022 309 3223
Email: clare.vesty@pg.canterbury.ac.nz



Social Validity Interview - Teachers

1. How often were the nature videos watched by any student in you class?

2. How often did (participants' name) self-select to watch the nature videos?

3. How effective do you feel the nature videos were is in reducing children's anger/frustration/restlessness/anxiety?

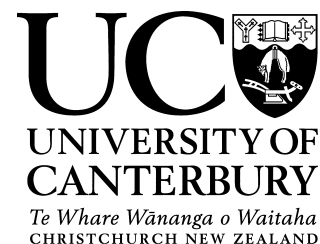
4. Please comment on any changes, if any, that you noticed after children had returned to their regular classroom activity after watching the nature videos.

5. Were there any notable difficulties you found having the nature videos available in your classroom that you would like the researcher to be aware of?

6. Were there any notable benefits/positives you found having the nature videos available in your classroom that you would like the researcher to be aware of?

Appendix N: Social Validity Interview Questions for Child Participants

Clare Vesty
Telephone: 022 309 3223
Email: clare.vesty@pg.canterbury.ac.nz

**Social Validity Interview- Child Participants**

Participant's Name: _____

I'd like to ask you a few questions about the nature videos you watched with me, and see how they worked for you. It should take about 10 minutes. Is that ok? Do you have any questions before we begin?

Did you like watching the nature videos? What did you like/not like about them (i.e. were they boring/exciting/interesting)?

How did you feel after watching the nature videos (i.e. happy, sad, angry, calm, frustrated)?
You can draw a picture showing me how you felt if you like.

Do you think you would watch nature videos again? Why/why not? If yes, when would you watch them?

Is there anything else you would like to say about the nature videos?

Appendix O: Events Diary

Consecutive School Day	Participants			
	Sarah	Reece	Anna	Jake
1	Baseline A1	Baseline A1		
2	Baseline A1	Baseline A1		
3	Baseline A1	Baseline A1		
4	Baseline A1	Baseline A1	Baseline A1	
5	Researcher Unavailable	Researcher Unavailable	Researcher Unavailable	
6	Non-nature Video	Absent	Baseline A1	
7	Non-nature Video	Non-nature Video	Baseline A1	
8	Non-nature Video	Non-nature Video	Non-nature Video	
9	Non-nature Video	Non-nature Video	Non-nature Video	Baseline A1 (No T2 data)
10	Researcher Unavailable	Researcher Unavailable	Researcher Unavailable	Researcher Unavailable
11	Researcher Unavailable	Researcher Unavailable	Researcher Unavailable	Baseline A1
12	Camp	Camp	Camp	Absent
13	Camp	Camp	Camp	Baseline A1
14	Camp	Camp	Camp	Baseline A1 (No T2 data)
15	Researcher Unavailable	Researcher Unavailable	Researcher Unavailable	Researcher Unavailable
16	Nature-Based Intervention	Nature-Based Intervention	Non-nature Video	Absent
17	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention	Baseline A1
18	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention
19	Researcher Unavailable	Researcher Unavailable	Researcher Unavailable	Researcher Unavailable
20	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention
21	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention
22	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention
23	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention
24	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention	Nature-Based Intervention
25	Baseline A2	Baseline A2	Nature-Based Intervention	Nature-Based Intervention
26	Baseline A2	Baseline A2	Baseline A2	Baseline A2
27	Baseline A2	Baseline A2	Absent	Baseline A2
28	Baseline A2	Baseline A2	Baseline A2	Baseline A2

Appendix P: Internalising and Externalising Behaviours Graphs

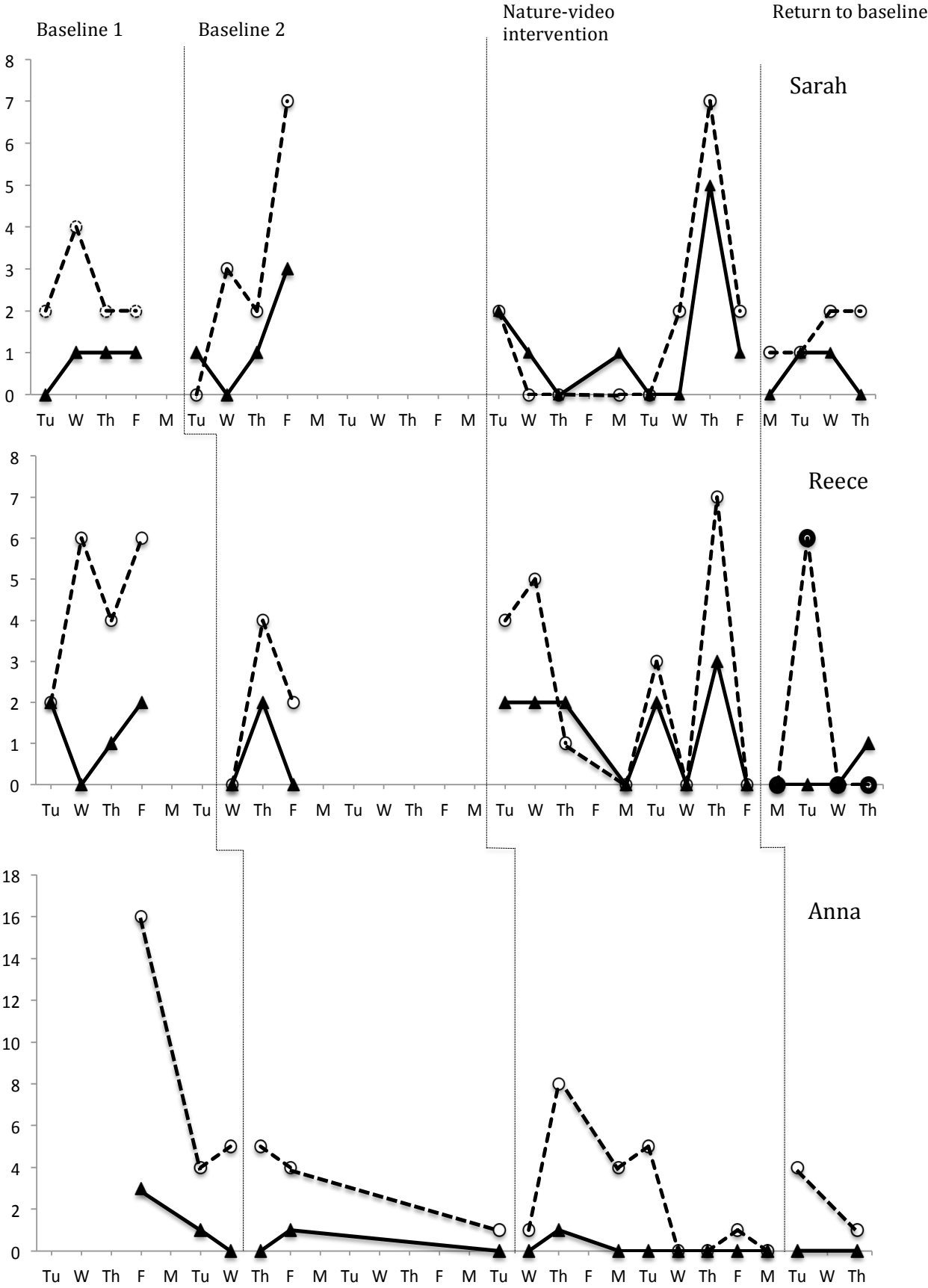


Figure P1. Sarah, Reece and Anna’s scores on the teacher-reported behaviour rating scale (TBR) separated by internalising and externalising behaviours across baseline 1, baseline 2, nature-video intervention return to baseline

Scores on the TBRS for internalising and externalising behaviours

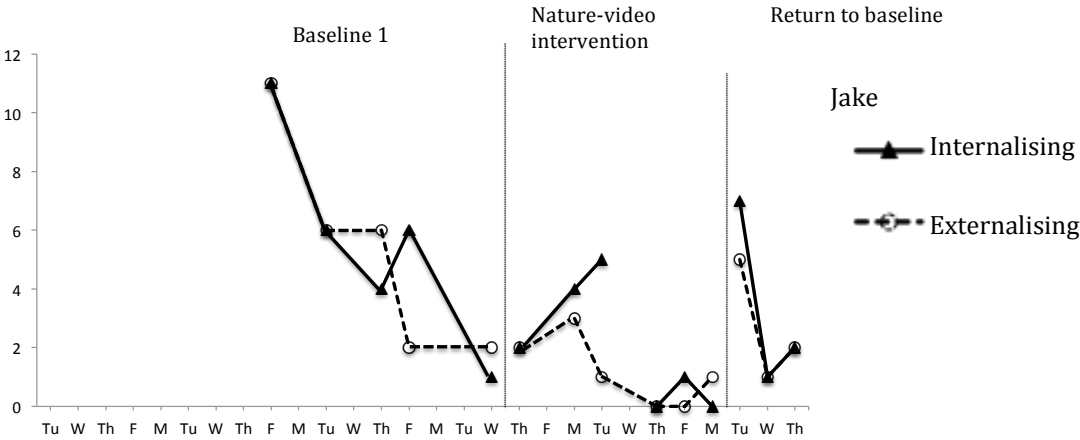


Figure P2. Jake’s scores on the teacher-reported behaviour rating scale (TBRS) separated by internalising and externalising behaviours across baseline 1, baseline 2, nature-video intervention, return to baseline.

Appendix Q: Inattentive Behaviour Graphs

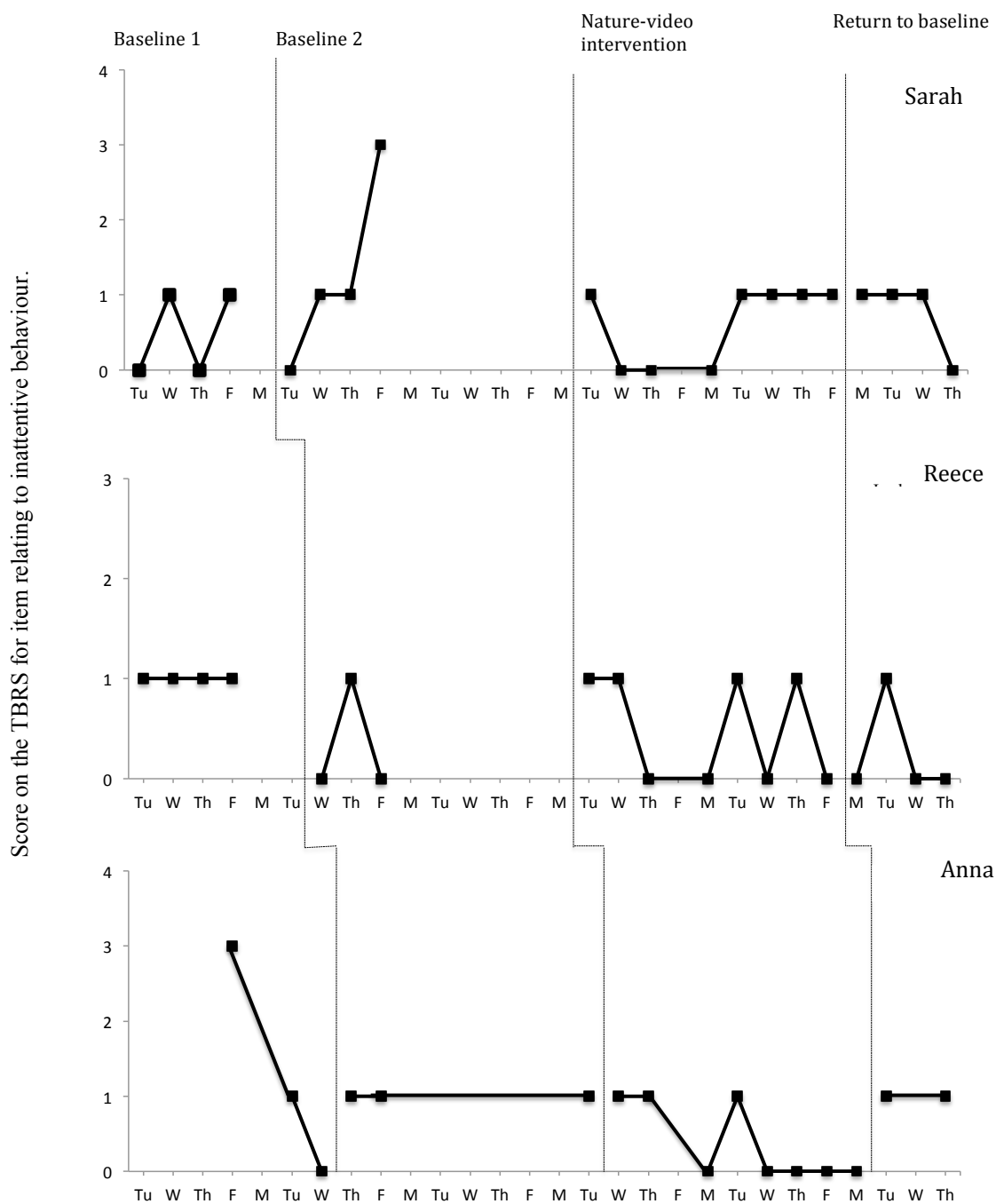


Figure Q1. Sarah, Reece and Anna's scores on the teacher-reported behaviour rating scale (TBRS) using only Item B which related to inattentive behaviour across baseline 1, baseline 2, nature-video intervention, return to baseline.

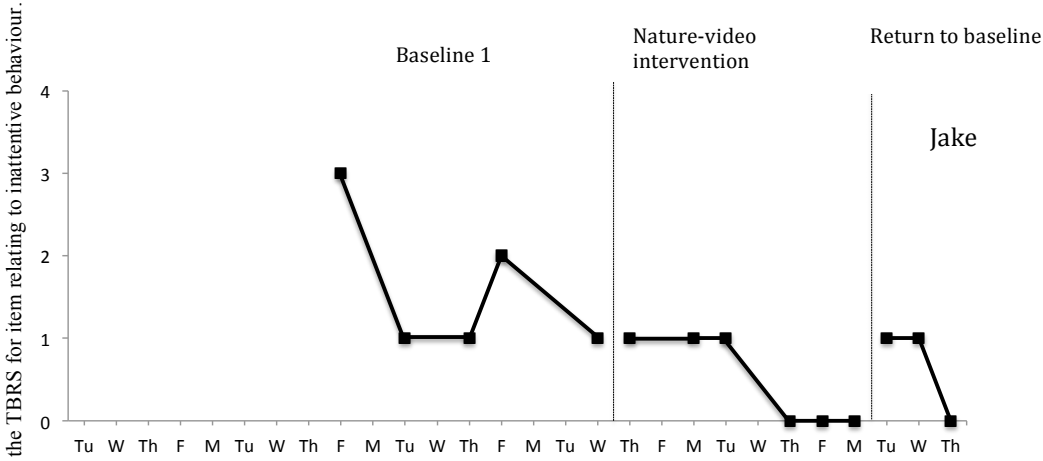


Figure Q2. Jake's scores on the teacher-reported behaviour rating scale (TBRBS) using only Item B which related to inattentive behaviour across baseline 1, baseline 2, nature-video intervention, return to baseline.